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by

James Young Wallace, III

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Changes In
Naval Aviation Basic Instrument Flight Training:
An Analysis

by

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ABSTRACT

To evaluate a modification to the Navy's Basic Instrument flight instruction, the performance of two groups of student aviators was compared. The modification consisted of a lecture concentrating on the fundamentals of attitude instrument flight. One group of 100 students received the new training while a control group of 100 students did not. Analysis of the flight grades of the two groups revealed no significant difference in their performance. Based on the results of this research it was concluded that the modified basic instrument training did not improve the performance of student naval aviators. However, the modified lecture and training did improve the student's understanding of basic instrument fundamentals. The study recommended that the modified lecture should be continued as part of the syllabus because the benefits from affording the student aviators with additional training exceed the small costs involved.

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I. INTRODUCTION

The overall objective of Naval Air Training Command pilot training is to produce commissioned Naval aviators qualified to meet the needs of the fleet. The student naval aviator begins his training in the Primary Flight Training curriculum which is conducted by Training Air Wing Five at the Naval Air Station Whiting Field, Florida. During this phase of training the student is taught how to fly in "instrument conditions" without the aid of outside the cockpit visual cues. The ability of the Naval aviator to perform proper instrument flight transforms periods of bad weather and low visibility from a liability to an asset for the successful completion of military missions. To achieve the proficiency necessary for "all weather" flying, the student aviator must acquire knowledge and skill in three areas: attitude instrument flight, instrument navigation procedures, and weather analysis. The Basic Instrument curriculum provides the requisite skill in the first area, attitude instrument flight. This thesis will investigate a modified training method introduced in the Basic Instrument Curriculum.

The modified training program was developed to correct deficiencies detected in student pilots' understanding of the basic concepts of instrument flight. The modification consisted of a training lecture, first presented in August 1985, focusing on the fundamentals of control coordination and timing, coupled with the fundamentals of attitude instrument flight. Introduction of the new training method presented this researcher with the opportunity to conduct an in-depth analysis using a quasi-experimental research design in an operational training environment. This study consisted of researching the history of basic instrument flight training to determine the rationale behind the training

modification; development of a research design to evaluate the impact of the new training on student aviator performance; and an analysis of the data generated by the experimental design.

The remaining chapters of this thesis provide detailed explanation of the research, data, and findings. First, the background of instrument flying and basic instrument training is discussed along with a description of the Navy's basic instrument curriculum. Then, A comprehensive literature review is provided to inform the reader of previous research conducted in this area and provide the basis for the research design. Next, the research design is presented including a description of the sample characteristics, the treatment, and the measurement device used. The data and accompanying analysis are described in Chapter V, followed by the research conclusions and recommendations.

II. BACKGROUND

A. INSTRUMENT FLYING

When flying was in its infancy, man understandably confined his flight operations to good weather in daylight hours. Therefore, early flight training was restricted to contact training under daylight conditions. The term contact refers to the technique of controlling aircraft attitude by reference to the ground and the horizon. Weather, in the form of rain, snow, clouds and fog obliterated the only reference (the ground and/or horizon) by which the early pilot could maintain the desired attitude of the aircraft. Numerous incidents of loss of control and subsequent crashes were caused by pilots inadvertently flying into inclement weather.

In the 1920's flight instruments were developed which made it possible to fly without visual reference to the ground or horizon, except during takeoffs and landings [Ref. 1: p.2]. When Jimmy Doolittle proved that man could take off, navigate, and land an airplane using no outside references, he introduced a system of instrument flight which we use, almost unchanged, to today [Ref. 2: p.31]. The new flying techniques which resulted were added to the training curriculum under the title "Instrument Flying". Eventually, Instrument flying came to be considered a unique skill. Soon this skill was refined and specialized to the point that a pilot who qualified as an instrument pilot was awarded a certificate to this effect. In order that the skill would not deteriorate, continual practice was found to be necessary. Thus today this certificate must be kept current by periodic practice, and annually the Navy pilot undergoes a formal flight test to demonstrate his competence. These certificates are awarded to civilian pilots by

the Federal Aviation Administration, and to military pilots by their service.

B. ATTITUDE INSTRUMENT FLYING

All flight is based on attitude flying, where attitude refers to the relationship of the airplane's axes to the natural horizon of the earth. Consider an airplane in flight with an xyz orthogonal axis system fixed relative to the aircraft: the x-axis is along the fuselage (running from nose to tail), the y-axis is along the wingspan perpendicular to the x-axis, and the z-axis is directed downward,perpendicular to the xy plane (parallel to the vertical stabilizer and rudder) [Ref. 3: p.264]. Rotational motion about the x-axis (or longitudinal axis) is called roll or bank; rotational motion about the y-axis (or lateral axis) is called pitch; and rotational motion about the z-axis (or vertical axis) is called yaw. Airplane control is composed of four components : (1) pitch control, (2) bank control, (3) yaw control, and (4) power control. Pitch control is the control of the airplane about its lateral axis by applying elevator pressure, through the control stick to raise or lower the nose , usually in relation to the horizon, thereby setting a nose "attitude". Bank control is the control of the airplane about its longitudinal axis by use of the ailerons to attain the desired angle of bank in relation to the horizon. Yaw control is the control of the airplane about its vertical axis by use of the rudder. Power control is the control of power or thrust by use of the throttle to establish or maintain the desired performance in coordination with the attitude changes. (see Figure 2.1)

When flying contact (with visual reference to the horizon), the performance of the airplane is controlled by placing the airplane's nose and wings in a specific position or "attitude" relative to the horizon. When operating in the clouds or during periods of low visibility (called instrument conditions), this external attitude reference

line disappears and reliable contact attitude flight cannot be continued. Attitude flight can still be accomplished during instrument conditions by replacing the actual horizon with the artificial horizon in the attitude gyro, a flight indicator instrument which provides the pilot with a visual representation of the airplane's orientation to the horizon (see Figure 2.2). The attitude indicator shows directly both the pitch and bank attitude of the airplane.

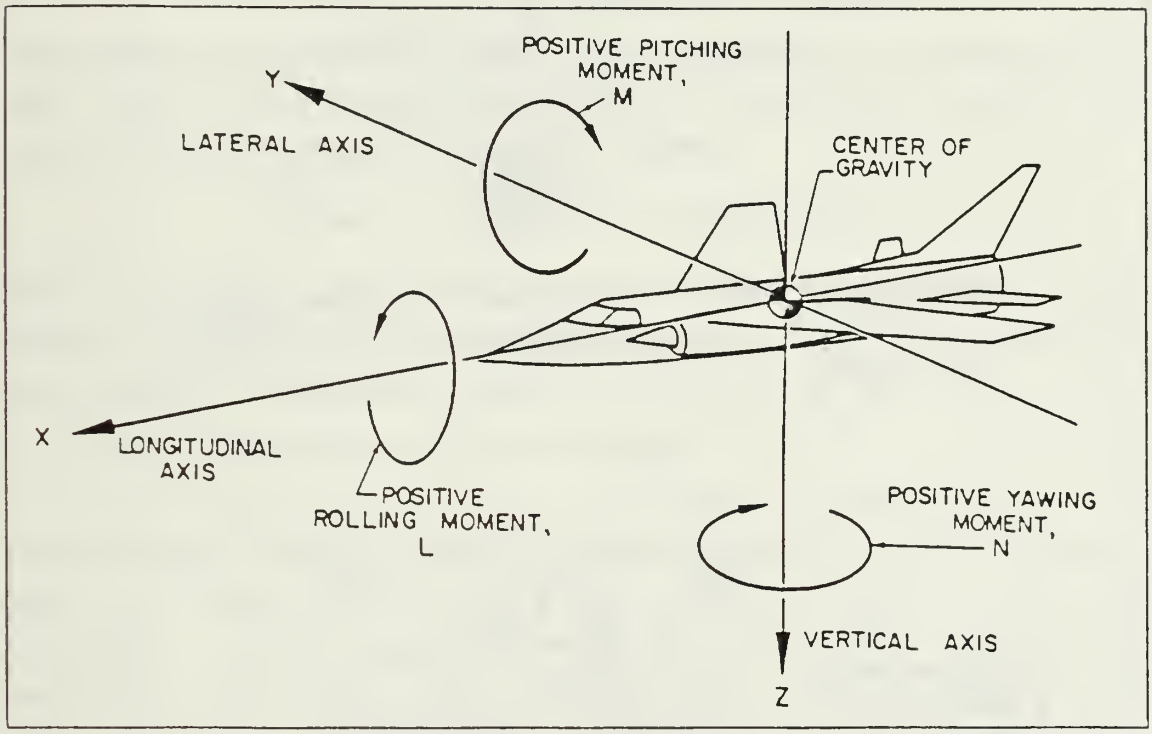


Figure 2.1 Control Axes of an Aircraft.

Other flight instruments, such as the heading indicator (RMI), altimeter, vertical speed indicator (VSI), turn and slip indicator, and airspeed indicator, are used to crosscheck the indications of the attitude gyro. The heading indicator shows directly the airplane's direction of flight; the altimeter indicates the airplane's altitude and, indirectly, the need for a pitch change; the vertical speed indicator shows the rate of climb or descent; the turn and slip indicator shows the rate of turn; and the airspeed

indicator shows the result of power and/or pitch changes by the airplane's velocity.

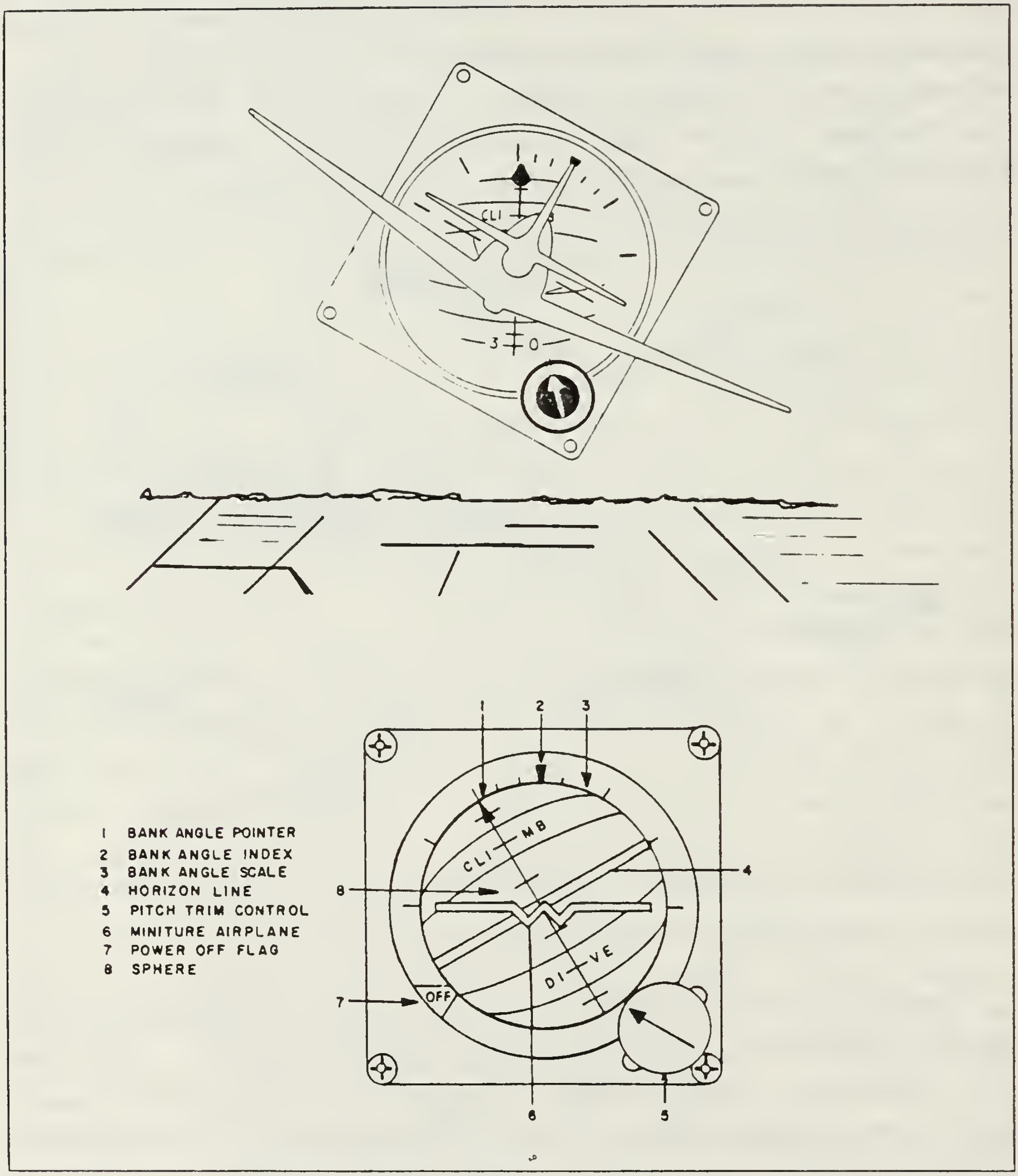


Figure 2.2 Visualized Attitude.

Success in instrument flight depends on the pilot's ability to see,not the instruments, but the picture they

portray. The pilot must interpret what is "seen" on the instruments and then take effective control action. Proper interpretation of this "vision through instruments" requires an understanding of: A) the functions, indications, and limitations of the instruments; B) the forces which make an airplane fly; and C)the reaction of the controls to those forces necessary to deliver the desired performance. By "scanning" the instruments, the pilot determines the attitude of the aircraft at any particular moment. If it is necessary to change the attitude, airspeed or configuration, the pilot uses power and control action to obtain the desired performance. In simpler terms:

Power + Attitude = Performance

Control forces are applied just as in contact flying to adjust the nose and wing position to the desired attitude in relation to the horizon [Refs. 4,5: pp.2,16-3].

C. BASIC INSTRUMENT FLIGHT TRAINING

The objective of basic instrument instruction is to provide the student pilot with the requisite skills necessary to perform attitude instrument flight. Like the concepts of instrument flying, the training methods for teaching instrument flying techniques have changed very little over the years [Refs. 2,6,7: pp. 31,5,2]. The beginning student is first given classroom instruction in the concepts of instrument flying including: explanation of the physiological factors related to instrument flying, the primary flight instruments, the fundamental flight attitudes, full-panel flying techniques, partial panel flying techniques(used when the primary instruments have failed), and instrument scan pattern techniques [Refs. 8,9: pp. 3-24,50]. Next, the student pilot is given instruction in a simulator, an airplane,or some combination of the two. Instruction in the aircraft is accomplished with the student under a "hood" which prevents him from obtaining outside

visual cues in order to simulate instrument conditions. The basic skills can be learned in as little as ten hours of flight time (including simulator time) [Ref. 7: p.13], although more advanced instruction in radio navigation and instrument approaches is required to achieve an instrument rating for both the military and civilian pilot. The Federal Aviation Regulations require at least 40 hours of instrument time under instrument weather conditions or simulated instrument conditions [Ref. 7: p.3].

As stated previously, there have been few changes to the training methods used in basic instrument instruction. For a long time in civil aviation, instrument flying was taught without reference to the attitude gyro, since many of the small private planes were not equipped with this instrument [Ref. 6: pp. 5,44]. Meanwhile, military aviation has taught attitude instrument flying techniques almost from the beginning. As more civilian aircraft became equipped with attitude gyros, attitude instrument flying became the standard for civilian training also.

The two most notable refinements in basic instrument training have been the increased use of simulators and the integrated contact-instrument training concept, which are discussed in chapter III. The use of flight simulators for instrument training began in military aviation with the purchase of the first "Link Trainer" in 1934 [Ref. 10: p.3]. As the simulators became more sophisticated, their usage increased to the point that today the military student pilot can expect to acquire over fifty percent of his instrument training in a simulator. See section B of chapter II for a more detailed discussion of instrument flight simulators.

Most civilian flight training and all military flight training incorporates the integrated contact-instrument training concept to some degree [Ref. 7: p.2]. From the standpoint of training, instrument flying is a logical extension of contact flying. The student pilot learns to use

the instruments and navigation equipment during contact flying, not necessarily to become an instrument pilot, but to develop the precision that is difficult to achieve without reference to the flight instruments. Consequently, the student pilot learns to fully utilize the potential of his airplane. The Navy uses the integrated training concept during the familiarization (contact) stage of primary training. The <u>Flight Training Instruction</u> states:

> In introducing the basic flight maneuvers, it is recommended that the "integrated flight instruction" method be used. This means that each flight maneuver will be performed by using both outside visual references and the flight instruments. When pilots use this technique, they achieve a more precise and competent overall piloting ability. That is, it results in less difficulty in holding desired altitudes, controlling airspeed during takeoffs, climbs, descents, and landing approaches, and in maintaining headings in the traffic pattern as well as on cross-country flights. The use of integrated flight instruction does not, and is not intended to, prepare pilots for flight in instrument weather conditions. It does, however, provide an excellent foundation for flight during Basic Instruments and Radio Instruments stages of training, and will result in the pilot becoming a more accurate, competent, and safe pilot. [Ref. 11: p.14]

D. THE NAVY'S BASIC INSTRUMENT TRAINING SYSTEM

The mission of Naval Air Training is: "To provide undergraduate pilot training and undergraduate flight officer training for Navy, Marine Corps, and Coast Guard personnel and selected foreign nationals." [Ref. 12: p.2-1] The overall objective of the Naval Air Training Command's pilot training is to produce commissioned Naval aviators qualified to meet the needs of the fleet. The student naval aviator begins his training in the Primary Flight Training curriculum. The Primary curriculum consists of six stages:

1. Familiarization (FAM)
2. Basic Instruments (BI)
3. Precision Landings and Aerobatics (PA)
4. Formation (FORM)
5. Night Familiarization (NF)
6. Radio Instruments (RI)

The training is sequenced in seven modules (MOD) which integrate flight support periods, flight instrument trainer (simulator) periods, and flights in aircraft. Academic training periods are scheduled during MOD-1 and MOD-6 and are completed in sequence without interruption for aircraft flights. [Ref. 13: pp.3-12] The research reported in this thesis will primarily be restricted to the Basic Instrument stage of training.

Primary flight training is conducted by Training Air Wing Five at the Naval Air Station Whiting Field, Milton, Florida. At this facility, there are three Primary Training (VT) squadrons, each having the same training curriculum and mission. Academic, flight support, and simulator training are consolidated; the actual flight instruction is done at the VT squadrons.The annual student load is approximately 1300. The flight instructors in the squadrons and, for the most part, the instructors in the academic and flight support departments are military officers (Navy, Marine and Coast Guard). The instructors for the simulators (both cockpit procedures trainer (PT) and flight instrument trainer (FIT)) are civilian instructors under contract to Burnside-Ott. Most of the Burnside-Ott instructors are former Navy or Marine Corps pilots with average military flying experience of more than 4,200 hours each [Ref. 14: p.18].

The aircraft used for Primary training is the Beechcraft T-34C "Mentor." It is an unpressurized two-place, tandem cockpit, low wing, high performance, single engine monoplane equipped with dual controls; power is provided by a Pratt & Whitney turbo-prop engine [Ref. 11: p.5]. With few exceptions, both cockpits contain identical controls and instruments (see Figure 2.3). The Flight Instrument Trainer, device 2B37, reproduces the front seat of the T-34C. The instructor sits at an outside console with three CRT displays which show simulator flight profile, cockpit

instrument readings, pilot control inputs, and status of aircraft systems [Ref. 14: p.18].

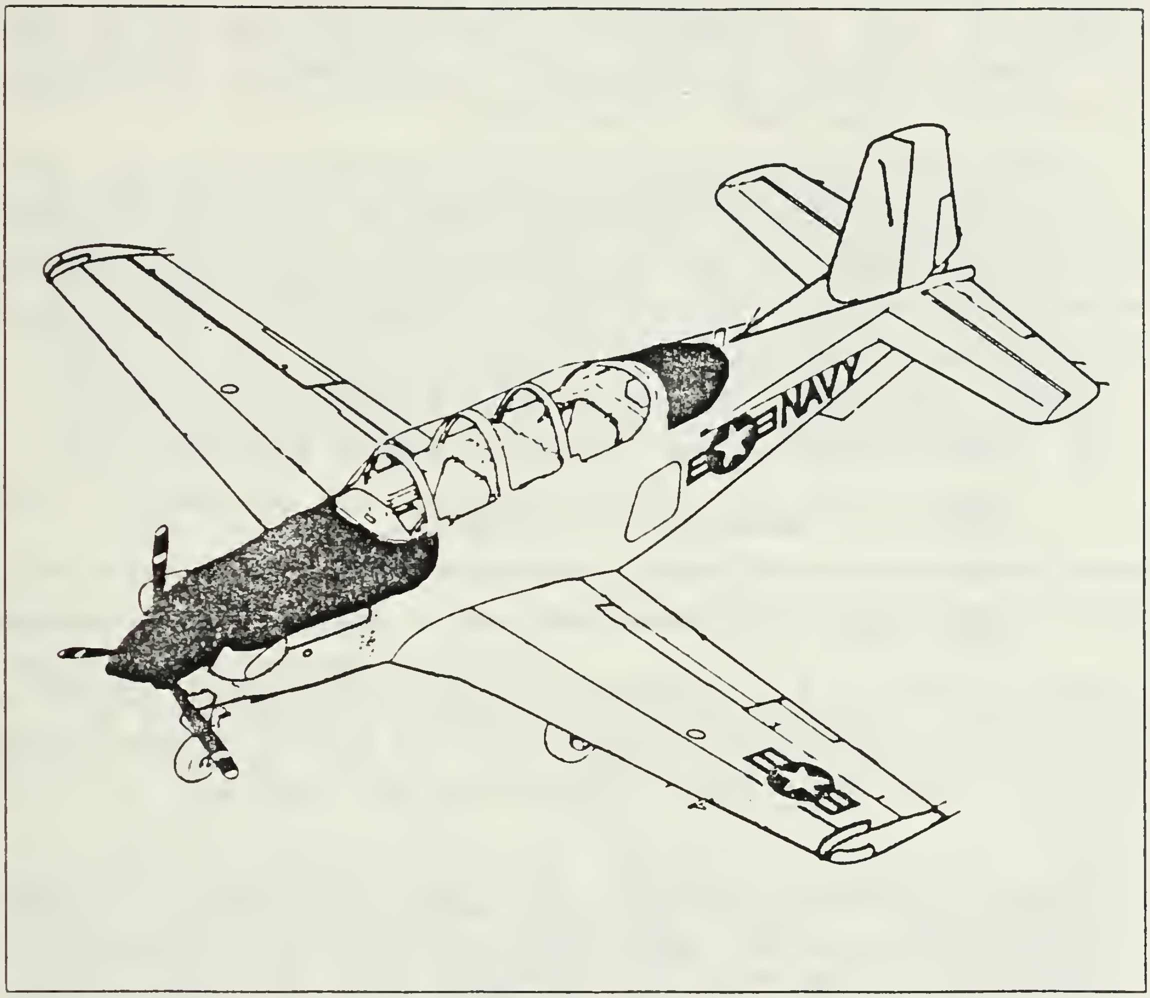


Figure 2.3 Beechcraft T-34C.

The Basic Instruments stage of training consists of one flight support lecture (3 hours), eight simulator periods (10.4 hours), and four aircraft flights (7.2 hours) for a total of 26.2 hours of instruction which includes brief and debrief time. The training is conducted in modules two and three. The flight support lecture covers basic instrument flight procedures and is given during the ninth week of training. The first basic instrument simulator flight (BI-1S) is flown after FAM-7, usually during the tenth week.

The final familiarization check flight (FAM-13) is normally flown prior to BI-4S, although BI-4S through BI-9S may be completed prior to completion of FAM-13. The remaining basic instrument flights are generally completed by the twelfth week of training [Ref. 13: pp.3-31].

Other than the increased use of simulators and the adoption of the integrated training concept, the Navy has made no major changes to the methods for teaching basic instrument flight skills. Historically, changes in pilot training programs have been the result of:

1. An urgent need for an increased number of pilots
2. Training deficiency or safety hazard in flying
3. Urgent need for pilots trained to do specific new functions, maneuvers, or missions
4. Urgent need for cost reduction
5. Innovations in training as a result of research [Ref. 15: p.1]

Lack of change is not necessarily an undesirable situation for pilot training, as stated in a 1968 Logistics Management Institute report on pilot procurement and training:

> The resistance to change in basic philosophy and/or method in pilot training is both understandable and appreciated. Since the risks associated with major changes can involve human lives as well as operational capability, they must be approached with the same degree of scientific rigor and development care that is used in the creating of a major weapon system. [Ref. 16 : p.34]

When attempting to change an established pilot training program one must proceed with caution.

E. MODIFICATION OF THE NAVY'S BASIC INSTRUMENT TRAINING

Small changes to pilot training methods do occur infrequently. The Navy's Basic Instrument Training Syllabus has recently been modified to incorporate such a change. Commander John F. Spahr, the Safety Officer of Training Air Wing Five, conducted a recent study of the basic instrument instruction provided to the student naval aviator. The study questions whether these aviators are skilled adequately in

the concepts, process, and control coordination required for efficient attitude instrument flight. Through interviews with flight instructors and student naval aviators, Spahr determined that there was a significant lack of understanding in some areas of instrument flight. He stated:

> It has been noted by twelve seasoned flight instructors, and determined by 108 interviews with flight students, that there is a significant lack of understanding in some areas, e.g. full panel unusual attitude recoveries involving level flight attitude and its relationship to airspeed. Furthermore, of 108 flight students interviewed by the author, in regards to the broad concept of attitude instrument flight, 92 indicated insufficient familiarity. Greater than 80 percent of these students had no direct familiarity with basic airwork, control coordination or motor skill reflex exercises associated with power and rudder or rudder and aileron. [Ref. 17: p.2]

Commander Spahr then developed a modified training program aimed at correcting the deficiencies he detected in the basic instrument instruction.

As discussed in section D of this chapter, the student pilots receive a Basic Instrument Flight Procedures lecture as part of the flight support section of the Basic Instrument curriculum during the ninth week of training. Spahr developed a modified lecture concentrating on attitude instrument flight fundamentals. He also developed a self-paced computerized instrument scan training program and a slide and audio tape presentation to be viewed on an individual basis in support of the lecture.

Commander Spahr has hypothesized that student pilots afforded this modified training will perform at a higher level during the flight stages of training, require fewer flights to complete training, and have fewer unsatisfactory (downing) flights. The remainder of this study will analyze this modified training plan and based on the data available determine the impact on student aviator performance.

III. LITERATURE REVIEW

A search of the literature on basic instrument flight training revealed numerous studies concerning the various facets of instrument training. Although none of the previous studies dealt precisely with the research topic of this thesis, each could offer insight into the problems, methods and background in the analysis of instrument flight training. Previous research in this area can be grouped into six major categories:

1. Integrated Contact-Instrument Flight Training
2. Use of Simulators for Instrument Flight Training
3. Effects of Prior Experience on Acquisition of Instrument Skills
4. Scan Pattern Training
5. Task Analysis of Flying Skills
6. Flight Instructor Grading

Studies concerning instrument flight training are too numerous to include each in this report. While the following discussion is not exhaustive, it is representative of the types of studies that provide insight into this area of research.

A. INTEGRATED CONTACT-INSTRUMENT FLIGHT TRAINING

There is a sizeable body of literature on the acquisition and retention of contact and instrument flight skills. The traditional approach to flight training dictated that the sequence of training be contact (day), contact (night), and finally instrument [Ref. 1: p.1]. The first reported attempt to change this order of training was made by Lee (1935) at the Boeing School of Aeronautics. He trained a group of students solely by reference to instruments for their first 23 hours of training. The results of this experiment were positive and Lee recommended that students

involved in long-term flight training should begin with instrument instruction. [Ref. 18: p.A-1]

Two decades elapsed before further work in this area was reported. Beginning in the mid-1950's and continuing through the 1960's, numerous studies were conducted by both civil and military aviation research teams concerning various aspects of the integrated contact-instrument concept [Ref. 18: p.A-2]. In a transfer effects experiment Ritchie and Michael (1955) observed that subjects who were given instrument training first showed a positive transfer effect on learning contact flying afterwards. This led them to conclude that instrument training could be conducted effectively prior to learning contact flying [Ref. 19]. Other studies produced similar results, although none of the studies offered definitive explanations concerning why the order of training produced significant differences. All of the studies were conducted with relatively small numbers of subjects in the control and experimental groups [Ref. 18: p.A-3].

All three branches of the military also investigated some form of early integrated contact-instrument training. The Air Force, through its Primary Flight Training Research Unit (1957) concluded that integrated training slightly improved primary pilot performance [Ref. 18: p. A-4]. The Army examined the feasibility of integrated fixed-wing training in the late 1950's and then contracted the Human Resources Research Office to conduct a comprehensive study in 1960-61 called INTACT [Ref. 18: p. A-4]. The results of this study, published by Prophet and Jolley in 1969, demonstrated that integrated contact-instrument primary flight training produces gains in primary maneuver flight proficiency but these gains do not carry over into advanced flight training phases [Ref. 20: p. vi].

In the INTACT study three groups of 36 students each received Army primary flight training under a different

training method program. Their performances in various phases of training were compared using both subjective grades of flight instructors and an objective measurement scheme. The study also evaluated the rate of attrition, the flight hour level at which check rides were passed, and the carry over effects of flight proficiency from primary phase to advanced phases. The rate of attrition did not vary between the groups undergoing integrated and non-integrated training methods. The integrated students had more total time (by about 3 1/3 hours) than the non-integrated students at the solo point due to the instrument training time. However they achieved the same level of contact flying proficiency with approximately 7 1/2 hours less contact flight time. It is significant to note that this was an operational evaluation program in which the training was conducted and performance data were collected within an operational training system as was done in the research reported in this thesis. [Ref. 20: pp. 22-24]

While there remains some controversy as to how much and what type of instrument training is sufficient to produce combat-ready aviators, all three services have adopted training programs in which instrument training is introduced very early in the training sequence [Ref. 18: p. A-4]. The Navy's primary training syllabus calls for the first basic instrument simulator flight after the seventh pre-solo contact flight and prior to the student's solo check flight, which occurs on the thirteenth contact flight [Ref. 13: p.23]. Training lectures supporting the instrument training are given earlier so that the student is exposed to basic instrument concepts very early in his flight training. Once the basic instrument training begins, the flights are fully integrated with the familiarization (contact) flights [Ref. 13: p.11].

B. USE OF SIMULATORS FOR INSTRUMENT FLIGHT TRAINING

The acquisition of complex flying skills through practice in a simulated, as opposed to actual, operating environment is a training concept that has been tested and applied throughout the history of aviation. Ground-based flight trainers (simulators) were not used widely until World War II when the need to train pilots quickly with few training aircraft led to rapid advancements in simulation technology [Ref. 21: p. 113]. Since that time simulators have become an integral part of both military and civilian flight training systems. The increased use of simulators was influenced in part because economic factors favored the use of the relatively inexpensive to operate simulator rather than the actual aircraft. Also, the simulator was useful in teaching skills too complex, expensive, or risky to practice in flight and the simulator provided the ability to isolate and practice particular segments of the overall task. As a result of the increased use of simulators, there have been numerous studies to evaluate their effectiveness.

The investigations of simulator training effectiveness were normally done as transfer of training experiments to determine if the training conducted in the simulator would transfer to the actual aircraft. The studies have almost universally demonstrated positive transfer of training from flight simulators to airplanes. For example, Williams and Flexman (1949) found that non-pilots could be trained to perform a series of maneuvers using a Link trainer and an aircraft in an alternating practice sequence in less time and with fewer errors than a group trained entirely in the aircraft [Ref. 21: p 113]. Another study by Ornstein, Nichols,and Flexman (1954) for the Air Force Personnel and Training Research Center demonstrated that the simulator is most effective for procedure loaded flight tasks [Ref. 22].

Other studies have contended that the fidelity of reproduction of the aircraft procedural and environmental cue

structure greatly affect the usefulness of the simulator. Jacobs and Roscoe (1975) reported that the amount of positive transfer of training from a ground-based flight simulator to performance in flight varied with the type of simulator cockpit motion [Ref. 21: p. 119]. On the other hand, Caro, Isley, and Jolley (1968) conducted an evaluation of an Army synthetic training program using a simulator and found no significant difference between students who had been given simulator training and those who had not [Ref. 10: pp. 17-19]. Perhaps the advances in technology in the years between the studies could account for the different findings. In a review of the literature concerning training effectiveness evaluations of flight simulators in the military aviation community during the 1972-1983 period, Browning and Pfeiffer (1984) determined that:

> Little transfer of training can be attributed to the addition of motion systems and related devices; however, motion systems contribute to pilot acceptance and use of training devices. [Ref. 23: p.9]

The preponderance of evidence that showed that training in the improved flight simulators could ensure complete transfer of training to the aircraft led the Federal Aviation Administration to permit simulator training as a substitute for certain in-flight training in civil aviation [Ref. 24: p. 25].

Instrument training is one area of flight training where flight simulators are almost universally used in all flight training systems. The instrument flight environment can be easily simulated and positive transfer of training to the actual aircraft has been clearly demonstrated [Ref. 25:p.1]. The Navy uses the full motion simulator of the T-34C aircraft, device 2B37, extensively for basic instrument flight training. Eight out of the twelve syllabus "flights" are conducted in the simulator [Ref. 13: pp.21-31].

Consequently, much of the data gathered for this research will be obtained from simulator flights.

C. EFFECTS OF PRIOR EXPERIENCE ON ACQUISITION OF INSTRUMENT SKILLS

Another area of research concerning instrument flying has attempted to determine the relationship between a pilot's prior contact flying experience and his ability to acquire instrument flying skills. This research is closely related to the integrated contact-instrument studies discussed earlier. One of the most thorough studies was conducted jointly by J.M. Childs, W.W. Prophet, and W.D. Spears for Embry Riddle Aeronautical University and the Seville Research Corporation under sponsorship of The Federal Aviation Administration Technical Center in 1980-1981 [Ref. 18].

In Phase I of the Embry-Riddle study three groups of university students received standard instrument training after varying amounts of total flight experience (67 hours, 100 hours, and 130 hours). At the completion of their instrument training each student was given a standardized instrument checkride. Objective and subjective measures of performance for the three groups were compared to determine the effects of prior flight experience on the acquisition of instrument flying skills. Childs, Prophet, and Spears [Ref. 18: p.27], concluded that:

> Within the range of pre-instrument flight experience examined in this study and for the subject population used, amount of prior flight time had no effect on the acquisition and demonstration of instrument flight proficiency.

In a follow-on experiment (designated Phase II), Childs and Holmes (1982) extended the findings of the phase I study to a more heterogeneous population, aircraft of greater complexity, and a training program conducted in a noninstitutional setting [Ref. 26: p iii]. The subjects in this

study had between 50 and 110 hours total flight time and their ages ranged from the early 20's to the mid 50's. They each completed 48 hours of instrument ground school instruction, transition flight training to ensure contact flying proficiency, and an instrument flight training program consisting of 14 hours of simulator time and 40 hours flying time. Three sets of data were collected:(1) measures of flight proficiency on a contact checkride administered prior to instrument training; (2) daily progress measures administered prior to instrument training; (3) measures of flight proficiency on the instrument checkride administered upon completion of instrument training. From the results of the study Childs and Holmes [Ref. 26: p.34], concluded that:

> Results of the present study support those of Phase I and extend them to an older, more heterogeneous subject population trained in a noninstitutional setting. On the basis of these findings, the amount of total prior flight time (within the 100-200 hour range) does not appear to be a valid indicator of student ability to acquire instrument flying proficiency.

Two related studies focused on the retention of instrument flying skills after initial training as related to the experience level of the pilot. In a study conducted at the Naval Postgraduate School in 1973, Smittle demonstrated that jet pilots with high total flight time performed instrument flying skills with a lower error rate than less experienced pilots. The experiment was conducted in a simulator and the subjects had not flown an aircraft for varying lengths of time [Ref. 27]. Similar results were reported in a study by Adams, Garner, and Mengelkoch (1971). In addition, they reported that discrete procedural responses were more susceptible to forgetting than continuous flight control responses [Ref. 28: p.1].

While insight can be gained from all of these studies, the Embry-Riddle studies are of particular significance for the current research. First, the finding that prior flight

time does not effect the acquisition of instrument flying skills was used to support the assumption that variances in prior flight time among the subjects in the current experiment is not a significant factor in establishing the equivalence of the control and experimental groups. Prior flight time data on the subjects in the current study was not available. Second, the research design of the current study is very similar to that of the Phase II study, in that data will be gathered on a contact checkride (pre-solo check), daily flight grades, and a final instrument checkride. Although the current study will not have the use of both objective and subjective criteria measurement as did the Embry-Riddle studies, the correlation between subjective and objective measures reported by Childs and Holmes supports this study's use of subjective measurement only. See Section F for further discussion of subjective flight instructor grading.

D. SCAN PATTERN TRAINING

The scan pattern used by pilots refers to the sequence in which they look at the various flight instruments in order to determine the attitude and performance of the aircraft at any particular moment [Ref. 4: p.3]. Numerous studies have been conducted to determine the optimal scan patterns for various flight maneuvers and to evaluate the feasibility of scan training techniques.

In a 1974 study by Haygood, Eddowes, Leshowitz, and Parkinson for the U.S. Air Force, an information processing model was developed to identify the information processing aspects of the pilot's flying task and to relate them to the student pilot's acquisition of flying ability. The study determined that with simple problems, auditory or visual information was equally effective when scanning time was unlimited, that visual pictorial information was more effective than visual verbal information when scan time was severely limited, and that there was no measurable effect of

audiovisual redundancy on concept attainment performance over the range of test tasks studied. The author developed the following optimal scanning procedure from the empirical results:

> Scanning should proceed at a slow but steady rate, allowing processing of such successive items of information on the control panel. The attempt here should be to allot enough time, say a fraction of a second, for processing and rehearsing of each reading on the control panel. Each instrument reading should be fully coded before additional information is scanned. A verbal code, rather than a pictorial or figural representation in visual memory is required if subsequent recall is to be maximized. Observe that the process should be serial, with information being processed item by item. [Ref. 29: p.46]

Furthermore, the authors suggested that experimental procedures could be developed to probe the student pilot's nonoptimal information processing strategies in order to evolve more effective flight training methods. [Ref. 29: pp.1-2]

Another study by Spady (1978) used a nonintrusive oculometer system developed for NASA to track the pilot eye-point-of-regard throughout instrument landing system(ILS) approaches flown by seven airline pilots in a simulator. Results from the study indicated that pilots used the attitude indicator as primary lookpoint and moved their lookpoint from the attitude indicator to another instrument and then back to the attitude indicator before checking another instrument. This is in agreement with the standard instrument scan techniques. The normal scan rate was determined to be 1.2 fixations per second. [Ref. 30: pp. 1-6]

In a 1984 study by Thode, Tremont, and Smith, eye movement training was investigated. A literature review conducted by the authors revealed a large body of work on eye movements related to reading and on relationship of eye movements to perception, but little having to do with training or proficiency of the perceptual motor skills involved in eye movement. The study examined a training program designed to enhance eye movement skills to determine

if Navy pilots' eye movements could be improved and if the improvement correlated with improvements in pilot performance. Results showed that eye movement skills were improved, but no relationship between the improved skills and available performance criteria could be identified. Among the recommendations presented was the suggested use of microprocessor-based presentation of stimuli for eye movement training. [Ref. 31: pp. 1-14]

A study conducted in 1975 by Komanski and Picton concerning the T-34C Expanded Primary Flight Training Phase for the Chief of Naval Air Training recommended a scan trainer as part of the primary simulation media. Komanski and Picton described the capabilities of the scan trainer:

> The Scan Trainer will meet the training requirements to train the Student Naval Aviator in the effective use of the eyes in performing pilot tasks. The trainer has the capability of providing training in eye accommodation exercises, speed reading of the flight instruments, and eye exercises to improve peripheral vision. The final training provided is time-sharing, which requires the Student Naval Aviator to speed read the instruments, make control movements to maintain desired flight attitude and at the same time, detect intruders which enter his field of vision. The pilot scan skill acquired by the Student Naval Aviator in the trainer will be applicable to pilot tasks throughout the Naval Aviator's career. [Ref. 32: p. 398]

The proposed Scan Trainer was never purchased.

The development of scan patterns is integral to basic attitude instrument flying. The current research investigates several scan training techniques. Information obtained from previous studies will provide background and suggest analytical methods for evaluating the proposed instrument scan training.

E. TASK ANALYSIS OF FLYING SKILLS

Many studies have investigated the topic of task analysis of flying skills, usually for the purpose of training system design. Together with the identification of flying skills, the problem of measuring these skills has been

evaluated. Most researchers discovered, as did Prophet, that:

> It is worth noting that there are fundamental and practical differences between the measurement of trainee performance with reference to cognitive objectives and the measurement of trainee performance with reference to complex psychomotor objectives (i.e. actual flight performance). The technology for cognitive skills measurement is relatively well developed and simple to implement in comparison with that for flight skills measurement. Thus, ability to carry out the intended hierarchical learning sequences in the flight training portion of the program, and even the simulator training portion, may be less than that for the academic portion by virtue of this factor. [Ref. 33: p.49]

In another study, Gerlach stated:

> Existing knowledge in the behavioral sciences often fails to provide an adequate base for the design of specific training programs in which the acquisition and maintenance of complex perceptual-motor skills is an expected outcome. [Ref. 34: p.1]

In a 1975 study for the Air Force on undergraduate pilot training, Gerlach determined that flying tasks are made up of procedures and technique. Procedures involve the steps in a sequence of responses and can be found in flight instruction manuals. Technique, on the other hand, consists of information on how to observe and manipulate the controls of the aircraft so that the desired flight parameter can be obtained. Gerlach contends that this information is not found in books, but is part of pilot "lore" which is passed on from the instructor pilot to the student aviator via word of mouth during preflight briefings or in flight [Ref. 34: p.5]. Similarly, Adams, Garner and Megelkoch stated that flying could be considered as having two classes of responses: procedural and visual-motor tracking. They defined visual motor tracking as a continuous response to a continuous stimulus and the smooth motor control of limb displacement [Ref. 28: p.4].

In the Gerlach study, student pilots' performance in flying a specific basic instrument training maneuver was measured after having received different cognitive pretraining. The results demonstrated that transfer from cognitive pretraining to perceptual motor learning is affected by the type of verbal instructional cue learned during cognitive pretraining. The study also addressed the issue of prescriptive principles for the design of perceptual motor instruction. Results from the control group indicated that an instructional procedure which merely supplies the learner with an objective or with a precise idea of the desired goal performance appears to be a more economical way to raise the instructional efficiency of pilot training than supplying the learner with explicit "how-to" cues which are very costly to develop. [Ref. 34: p.23] This approach, however, could very likely lead to standardization problems between students.

Komanski and Picton (1975) conducted a situation analysis study of the T-34C Expanded Primary Flight Training for the Chief of Naval Education and Training to determine the simulation and training media requirements. The study determined terminal behavioral objectives and then specific behavioral objectives and supporting enabling behavioral objectives were formulated. Domain and level were assigned, using Bloom's <u>Taxonomy of Educational Objectives</u>. From the results of the study, a complete simulation and training media package was recommended. [Ref. 32: p.391]

Another study concerning alternative designs for Navy Undergraduate Pilot Training was conducted by Browning, Drehl and Scott in 1975 [Ref. 35: p.24, p.101]. These researchers chose the classic "stimulus-organism-response (S--O--R)" paradigm for its ease of applicability to task analysis. In the S--O--R model used, the functions were described as:

STIMULUS

Cues sensed from inside the cockpit such as a light, position of an instrument needle, from a control feel and from out of cockpit such as other aircraft, velocity, height or altitude cues.

ORGANISM/OPERATOR

Information processed from cues, interpreted, mental calculation performed, rules or past experiences recalled, and decisions made on handling.

RESPONSE

Responds by movement of stick, rudder, power lever; pressing a button; or verbal response.

The S--O--R commonality analysis was used to assess the potential for transfer of training among the various phases of undergraduate pilot training. In their investigation of basic instrument training the researchers suggested that the training maneuvers and skills that purport to transfer to operational instrument flying should be taught and practiced in a functional context. For example, the slow flight maneuver could be practiced while flying a holding pattern and partial panel flight could be practiced while making a letdown and instrument approach.

More recent studies have been conducted under the Instructional System Development (ISD) guidelines established by the Department of Defense for all instructional development. ISD is all-pervasive in naval aviation; it is the specification to which all new naval aviation training syllabi are designed and most existing syllabi are being retrofit, including the primary training command [Ref. 36: p.102]. ISD begins with task analysis followed by determination of objectives, and finally the choice of training media based on a balance of cost and educational

effectiveness. Aviation training is one of the most costly types of military training because of: (1) the difficulty of the skills involved requiring years of training; (2) the extremely high quality of the personnel resources required to operate and maintain aircraft; and (3) the high hourly operating costs of the increasingly complex aircraft [Ref. 33: p. 65]. ISD has the potential for maintaining or improving the quality of training at the least possible cost, although some training experts question whether ISD has achieved these goals.

In 1978 Prophet analyzed four specific Naval Aviation ISD programs (i.e. the A-6E, E2C, EA-6B, and SH-2F) with regard to the extent to which the programs moved toward the goal of more cost effective training. The study found that the four programs devoted much more attention to the cognitive area than to the flight skills area (both aircraft and simulator). Prophet stated that for significant increases in cost effectiveness in aviation training, emphasis must be on in-the-cockpit flight skills as opposed to emphasis on cognitive skills. [Ref. 33: p.69]

Prophet also recommended functional context training in aviation training as did Browning, et al. in a previously mentioned study. Prophet stated:

> It is logical that one should learn the cognitive enabling skills first in the classroom (or in a carrel, or from a programmed text, etc.) before those skills are used in the cockpit. However, it has been our experience that many such "enabling" items can best be learned directly in the cockpit context when and as they are needed in the flight mission performance. Thus, in some programs the classroom has been virtually eliminated as the locus of instruction in favor of the procedures trainer or simulator. Not only does this provide a true functional context for the instruction, with attendant benefits to both learning and retention, it results in the elimination of much material that was previously felt to be essential based on usual assumed hierarchical relationships. As a result, such programs have much smaller and simpler media requirements. [Ref. 33: p.69]

The previous research on task analysis of flying skills has provided guidance for the current study. Since Navy

aviation training is currently conducted under ISD concepts, the Prophet study was particularly relevant. The research by Gerlach on cognitive pretraining provided excellent background, considering the similarities in research design to the current study. Task analysis is essential to the understanding and evaluation of any training program.

F. FLIGHT INSTRUCTOR GRADING

Each of the previously discussed studies had to use some method for evaluating the performance of the subjects, generally pilots or student pilots in whatever research design that was being used. The most common device used was some form of flight instructor evaluation of the subject. These might take the form of objective measures, such as the Pilot Performance Description Record (PPDR) developed by Smith, Flexman, and Houston (1952), Greer, Smith, and Hatfield (1962), and Prophet and Jolley (1969), used in the Embry-Riddle studies [Ref. 18: p.10]. Or, more commonly, subjective instructor evaluations of student pilot progress are used, because excessive costs, disruption of training in an operational setting, and safety of flight considerations often preclude the use of objective performance measures. In addition to each individual study having to evaluate the flight instructor measurement criteria, several studies have been conducted which were devoted entirely to this problem.

One of the earliest studies concerned with flight instructor grading was conducted by Bennett and Doppelt in 1949. The study reviewed the flight training jackets of military aviators and found biserial coefficients ranging from .18 to .26 between numerically expressed grades given by the student's own instructor early in the training program and subsequent success in completing training. In addition, coefficients from .17 to .45 were found between grades given by check flight instructors and subsequent success. [Ref. 37]

In a similar study by Martoccia and Nelson (1956) a .17 coefficient was determined for the relationship between instructor grades and subsequent success or failure of students in Naval Basic Air Training [Ref. 38: p. 2]. The researchers also investigated the correlation between the expressed opinion of the flight instructor as to the student's probability for success and actual success, obtaining a correlation coefficient of .30 [Ref. 38: p.4]. Ambler, Shannon, and Waag conducted similar research in 1973 and reported essentially the same results. In their report they also discussed the role of the flight instructor and the possible biases to his evaluation of student performance:

> The flight instructor is required to serve a dual function. Although his principle duty is to teach students to fly, he must also evaluate their progress for the record. Such evaluations are reflected in grades which become a permanent part of the student's flight jacket and are subject to the scrutiny of both the training command and subtle pressures involved in face-to-face evaluations. Therefore, it is possible that an instructor's actual opinion regarding a student's progress may not be completely reflected in the grades he assigns. [Ref. 39: p.1] .

Caro conducted an analysis of grading practices and procedures in effect in rotary wing training at the U.S. Army Aviation School during the 1961-1963 period. He determined that the performance checks in use served two purposes: a) they demonstrated whether the student met the required standards of performance, and b)they provide information that serves as feedback to the personnel responsible for administering the overall instructional system. Coefficients of correlation were computed between instructor assigned grades and checkpilot's grades given on end of stage checkrides in order to check for commonality of standards. A Pearson product moment coefficient of .48 was computed for the Instruments/Cross-Country stage of training, indicating substantial agreement between

instructors and checkpilots in assignment of grades. Caro also found that the end of stage evaluations were significantly affected by :

1. The individual standards and grading practices of the check pilot.
2. The checkpilot's prior knowledge of student performance
3. The comments of previous instructors on the evaluation forms.
4. The stage of training.

Findings from this research indicated that individual check-pilots did have standards and grading practices which differed enough that a student's grade could be influenced significantly by chance factors in assignment of students to checkpilots for evaluation. [Ref. 40: pp. 7-16]

Since the present research uses the subjective evaluations of student naval aviators by instructor pilots as the measurement of performance, the value of these previous studies is in highlighting the possible areas of instructor bias and the reliability of flight instructor evaluations. In studies where both objective measures and subjective flight instructor evaluations were used, a generally high correlation was found to exist between the two measures [Refs. 1,18,20,21,26,30,34].

The current research seeks to apply many of the analytical and empirical approaches revealed in this review of the literature. Since previous research has not dealt precisely with this phase of instrument skill training, extrapolation from similar studies is important and necessary to the current study. In addition, the current research will add to the body of knowledge concerning experimental research conducted in an operational training environment.The works by Campbell and Cook [Ref. 41] and Campbell and Stanley [Ref. 42] on the design and conduct of quasi-experiments in field settings provided excellent guidance for the current research effort. The literature covered in this chapter formed the basis for the research design in the current

experiment which will be demonstrated in the following chapters.

IV. METHOD

A. RESEARCH DESIGN

The research hypothesis proposed by Commander Spahr was that flight training concentrating on the fundamentals of control coordination and timing, coupled with the fundamentals of attitude instrument flight, would produce higher performing student naval aviators who would require less time to train [Ref. 17: p.10]. In order to test this hypothesis, a modified quasi-experimental cohort design was chosen which could easily be implemented in the existing training environment. Two cohorts of students who received flight training at different times were identified -- one the experimental group and one the control group. The experimental group received the treatment (modified basic instrument training) while the control group did not. Individual student performance data was collected to ascertain the validity of the research hypothesis.

For reasons, such as flight safety, inadequate performance measures, and interference with ongoing pilot production, it is clear that true experiments are exceedingly difficult and costly to conduct within flying training units. As Browning and Pfeiffer stated in a 1984 study concerning research designs for field evaluations of aviation trainers:

> While controlled experiments are desirable, practical considerations dictate that other forms of evaluation also be considered. Whatever the evaluation strategy employed, it must be capable of producing data acceptable for answering the specific evaluation questions being posed. [Ref. 23: p.13]

In this study the evaluation strategy chosen was the quasi-experimental cohort design, which has the advantage of less

interference with ongoing training, requires less time, and costs less.

Some organizations, such as the Naval Air Training Command, have regular turnover as one group of students graduates to another level of the organization. Two factors make such a rotational system useful for quasi-experimental design. First, groups which precede treatment groups in undergoing some training experience can often be assumed to have had the same organizational experience as the treatment group except that they never received the treatment. And second, the students in the non-treatment cohort group can sometimes be assumed to be similar on many background variables to the students in the treatment cohort group. [Ref. 41: p.263]

As noted by Campbell and Cook, selection cohort designs (referred to in this report as simply cohort design) without a pretest, i.e. with a treatment and posttest only, are not as strong as selection cohort designs with a pretest [Ref. 41: p.264]. In addition, Campbell and Stanley (1963) noted that it is not essential that pretest and posttest be identical and that other information can sometimes be substituted for a pretest [Ref. 42: p.196]. In this study there was no formal pretest, however other forms of information were available to demonstrate equivalence of the groups (see Section B). The posttest was the end of Basic Instruments stage checkride (BI-12).

B. GROUP DEMOGRAPHICS

The selection of flight students for the two groups was accomplished in the following manner. The control group was composed of students entering training during the month of June 1985. The experimental (treatment) group was composed of students entering training during the month of August 1985. To avoid contamination of the control group by the experimental group a sixty day separation between starting dates of training for the two groups was chosen. Both groups

contain 100 students who are members of the Navy, Marine Corps, Coast Guard, or a foreign military service. All of the students are college graduates with Bachelor of Arts (BA), Bachelor of Science (BS) or equivalent degrees. Testing criteria applied to each student prior to selection for flight training indicate that their academic abilities are relatively similar. New students are equally distributed to the three VT squadrons at Whiting Field on a random selection basis.

The aviation selection tests used by the Navy, Marine Corps and Coast Guard consist of four paper-and-pencil subtests divided into two parts: the Academic Qualification Test (AQT) and the Flight Aptitude Rating (FAR). The AQT is a test of general intelligence that is particularly adapted to prediction of ground school performance. The FAR is an index that forecasts the likelihood that an applicant will successfully complete Undergraduate Pilot Training. Performance on the AQT and FAR is scaled in "STANINES, the contraction for "Standard Nines". The scores range from 1 to 9 and have a mean of 5. The cut-off scores for the AQT-FAR are 3-3 for Officers Under Instruction and 3-5 for Aviation Officer Candidates (AOCs). The AQT-FAR are not administered to foreign students. [Ref. 43: pp.1-5]

Summary demographic data on the control and experimental groups are presented in Table I . The mean AQT-FAR scores for the control group were 5.3-7.0; for the experimental group the mean scores were 5.2-7.2. Both groups consisted of two females and 98 males. The age of the students in the control group ranged from 21 years to 30 years with an average age of 24.3 years. In the experimental group the students' ages ranged from 22 years to 30 years with an average age of 24.2 years. The distribution of college degrees in the experimental group was 35 percent BA and 65 percent BS, while the control group had 27 percent BA and 73 percent BS. This slightly higher percentage of technical

degrees could account for the small difference in AQT scores between groups. The control group contained 64 Navy students, 22 Marine Corps students, 5 Coast Guard students, and 9 foreign students. The experimental group consisted of 81 Navy students, 14 Marine Corps students, 2 Coast Guard students, and 3 foreign students. The different service distribution is not considered to be a significant factor since the officer selection criteria is basically the same for each of the services. The academic ground school was completed by these students prior to the June and August start of flight training dates used to select the two groups. These scores provide excellent pretest data to indicate the similarities of the groups. The control group had a mean test score of 47.8, while the experimental group's mean test score was 46.2. Complete demographic data is contained in Appendix A.

TABLE I

CONTROL AND EXPERIMENTAL GROUP DEMOGRAPHIC DATA

Subjects by Sex		AGE		DEGREE		AQT SCORE		FAR SCORE		ACADEMIC GRADE	
M	F	Mean	SD*	BS	BA	Mean	SD	Mean	SD	Mean	SD
CONTROL GROUP											
98	2	24.3	1.6	73	27	5.3	1.4	7.0	1.7	47.8	10.6
EXPERIMENTAL GROUP											
98	2	24.2	1.9	65	35	5.2	1.3	7.2	1.5	46.2	10.1

* Standard Deviation

Based on the demographic data the two groups were essentially equivalent in all characteristics of significance to this research. As can be seen in Table I , differences between the groups are trivial. This is likely the result of

the rigorous screening process for selection for flight training. Although there is no statistical procedure for exactly equating groups [Ref. 41: p.251], these two groups can be considered to be as equivalent as possible. The Familiarization stage checkride (FAM-13) grade was also used as a measure of equivalence and this data will be presented in Chapter V.

C. TREATMENT

The student pilots receive a Basic Instruments Flight Procedures (BIFP) lecture as part of the flight support section of the Basic Instrument curriculum during the ninth week of training [Ref. 13: p.21]. The treatment consisted of a modified lecture prepared and presented by Commander Spahr. In the new BIFP lecture which concentrated on attitude instrument flight fundamentals, Spahr also demonstrated the use of a self-paced computerized scan training program and assigned a slide and audio tape presentation for individual viewing to support this lecture. The scan training program was never used due to lack of support facilities, i.e. an adequate number of microcomputers for student use. Appendix B contains the contents of the new BIFP lecture. Four guidelines were established for the students' participation in this program:

1. They would study and absorb the lecture materials and handouts as they would any other academic course.
2. They would practice, on an individual or group basis, the basic coordination drills demonstrated during the lecture.
3. They would use the Training Center's facilities to view the slide and tape presentation provided for them on an individual basis.
4. The instructor would serve as a guide, resource, and facilitator.

D. INDEPENDENT VARIABLES

In this research the independent variable is the present or modified BIFP instruction. The modified instruction includes the lecture, the slide and audio tape presentation, and the basic coordination drills. These variables incorporate the concentrated training and attitude instrument flight fundamentals listed the the research hypothesis.

E. DEPENDENT VARIABLES

Three aspects of the performance of the students is measured in the two treatment conditions (treatment or no treatment) and recorded after the treatment has been administered. These are:

1. Flight performance in the entire BI stage.
2. Flight performance on the end of stage checkride.
3. The number of poor performance or unsatisfactory flights.

The change in flight performance is based on grade point averages on the various flights. The measurement of the poor performance flights will be based on the average number of unsatisfactory flights. An unsatisfactory flight usually requires that additional training flights be flown prior to progressing in the syllabus. Thus, a reduction in the average number of unsatisfactory flights would mean a reduction in the average time to train.

F. MEASUREMENT

Measurement of student pilot performance was accomplished with instruments already in existence: the subjective grading of students by instructors on various syllabus flights. Although objective measurement criteria would have been preferred, excessive cost, disruption of training, and safety of flight considerations precluded the use of objective performance measures (see Section F of Chapter II for a more detailed discussion of the use of subjective grading in flight training studies).

The student's performance in conducting various flight maneuvers is evaluated by the instructor and recorded on an Aviation Training Form (ATF). Copies of the ATF's used in this research are contained in Appendix C. Each maneuver is evaluated as unsatisfactory (1 point), below average (2 points), average (3 points), or above average (4 points) and then an average for the flight is computed on a four point scale. Comparison of student performance between the two groups was accomplished by comparing the grade point average (GPA) on various maneuvers, flights, and cumulative GPA's for the various stages of training. In addition, the average number of unsatisfactory flights was compared. The raw data from the ATF's was transferred to computer storage by use of the Data Management System (DMS) at the Naval Postgraduate School. Statistical tests were performed using the Statistical Analysis System computer program [Ref. 44].

The Navy flight instructor grades the student using norm reference measurement procedures, whereby he evaluates the performance of the student in relationship to norms established by the performance of previous students who received the same training [Ref. 13: p.7]. The instructor first learns these norms in instructor training programs and then reinforces or modifies the norms as he trains additional students. In addition to comparing the performance of the student to other students, he compares the student to his own (the instructor's) ability to perform a specific flight task. In evaluating a flight maneuver, some aspects of the pilot's performance can be assesed by observing the aircraft's instruments. These observations are more objective than other aspects of each maneuver which are evaluated by making judgements as to the maneuver's tightness, smoothness, and so forth.

In general, the performance evaluations given by experienced flight instructors are relatively accurate measures of

student pilot proficiency, as noted by Burger and Brictson in a transfer of training study concerning Navy pilots:

> Due to the extensive flight and training experience of most instructor pilots, performance ratings are probably quite reliable and valid. [Ref. 45: p.42]

Evaluation bias can result from the inherent subjectivity of the instructor, i.e. his individual tastes, performance standards, and perceptions of the performance of students. If the assignment of students to instructors is random and if the sample is large (as is the case in this research), there will be no systematic bias [Ref. 46: p.7]. Drucker and Uhlaner in a study on military performance criteria found that the use of multiple evaluators is likely to increase the validity of performance ratings [Ref. 47: p.132]. In the Basic Instrument stage of training the student can have a different instructor on every flight; the students in this study averaged ten different instructors for the twelve flights.

If the treatment causes an increase in performance by the student naval aviator, this should be reflected in higher grades on the various maneuvers affected. The instructors' norm referenced evaluation system is based on previous experience with student performance and any increase in student performance should result in the instructor awarding higher grades, at least in the short term. Eventually, as this new level of performance becomes the norm, student grade averages should lower as the instructor will grade the same level of performance as average that was previously above average. Nevertheless, the flight grades recorded on the ATF's should prove to be adequate for this research.

G. ANALYSIS PROCEDURES

In evaluating the training method change in Basic Instrument training, a qualitative analysis of the modified BIFP lecture and a statistical analysis of the performance data was accomplished. The results are presented in Chapter V. The qualitative analysis centered around the following type of questions:

1. Were the goals of the training clear to both the organization and the students?
2. Were the methods and content of the training relevant to the goals?
3. Were the proposed methods actually used and the proposed content actually taught?
4. Did it appear that learning was taking place?
5. Is the modified training program in conflict with any other training program in the organization?
6. What kinds of criteria should be expected to show changes as a result of the modified training? [Ref. 48: p.308]

Quantitative analysis of the performance data was conducted using standard statistical techniques. In evaluating whether two sets of data (e.g. the control group and the experimental group) differ to a degree greater than might be expected by chance, various statistical significance tests are used. In the present research, these are the "t-test" and the analysis of variance (ANOVA). See Appendix D for a further discussion of statistical analysis procedures.

V. PRESENTATION OF DATA AND ANALYSIS

A. QUALITATIVE ANALYSIS OF TREATMENT

The treatment in this research consisted of a new lecture which supplemented the Basic Instrument Flight Procedures (BIFP) lecture that was presented to the students prior to the simulator and aircraft flights. The previous BIFP lecture was given by flight instructors from one of the squadrons. Since presentation of this lecture was a collateral duty for the instructors and assignment of an instructor might vary from lecture to lecture, specific guidelines for the lecture were published (see Appendix E). The content of the lectures could vary slightly with the different instructors.

The original BIFP lecture was primarily a repeat of the information contained in the Flight Training Instructions (each student has a copy) concerning basic instrument flying. The lesson outline followed the content of the FTI, referring to specific paragraph and page numbers. The instructor could give the lecture by simply reading portions of the FTI to the students. The lecture concentrated on basic instrument procedures with some instructor "gouge" on how to best accomplish the procedures for particular maneuvers. Very little coverage of fundamentals and underlying basic instrument concepts occurred.

The treatment lecture was given by Commander Spahr to the experimental group immediately following the presentation of the old BIFP lecture. The original lecture took approximately forty-five minutes while the new lecture was a two hour presentation. The treatment lecture covered new material which for the most part had not been previously available to the flight student in either lecture format or training publications (see Appendix B). The emphasis was on the "how and why" of basic instrument fundamentals as

opposed to the procedures emphasis of the previous lecture. Copies of the lecture were distributed to the students.

Four major areas were presented in detail in the new lecture:

1. Power Attitude Trim (P.A.T.) principle.
2. Motor skills coordination exercises.
3. Unusual attitude recovery.
4. Partial panel instrument flight.

The P.A.T. principle reinforces the "power plus attitude equals performance" concept discussed in Section B of Chapter II and is the basis for effective attitude instrument flying. The detailed explanation of the P.A.T. principle included basic aerodynamic relationships and examples of application of the principle to the various basic instrument maneuvers. The P.A.T. principle was mentioned in the previous BIFP lecture, but not fully discussed.

The motor skill coordination exercises which were not previously taught constitute a primary part of the treatment. The objective of the exercises is to allow the student to practice application of the P.A.T. principle on the ground in order to make it a reflex operation in flight. The student simulates the timing and coordination of power lever movement, flight control movements, and trim for the various basic instrument flight maneuvers using his hands and feet. The student was to practice these exercises on his own prior to the flights. Compliance by the students was not ascertained. Exercises of this type have been taught to students previously by some flight instructors on an individual basis. However, these exercises were not previously a formal part of flight instruction.

Unusual attitude recovery and partial panel flying were presented in much the same manner as the P.A.T. principle. Basic aerodynamic principles were discussed along with the fundamental concepts to give the student a better understanding of the techniques involved. Again the emphasis was

not on the rote memorization of procedural steps, but on understanding what was happening to the aircraft in an unusual attitude and the proper techniques for returning the aircraft to a normal level flight attitude.

In analyzing this treatment lecture, the researcher observes that the goals of the training were clear to both the students and the training organization. The method chosen to improve instrument training was relevant and had the potential to be effective. The students responded favorably to the lecture and appeared to understand the concepts being taught. None of the new material taught was in conflict with any existing training doctrine. The slide and audio tape presentation supported the lecture with pictures of the flight instruments in the various maneuvers with accompanying explanations. The presentation was available for individual viewing, although actual usage was not determined. According to Miller [Ref. 49: p.221], a student can be trained to associate a task stimulus with a concept of the stimulus and the task response with a concept of the task response. When these two sets of associations have been established, a considerable amount of pretraining can be done at the verbal level, with expectation of positive transfer to the motor-skill task. This verbal training can reduce the confusion and trial-and-error with which the student approaches learning in the actual task environment of flight. It also permits rehearsal of procedures when away from the actual cockpit.

B. DATA COLLECTION

The data for this research was collected from the three Primary Training Squadrons (VT-2, VT-3, VT-6) at Naval Air Station Whiting Field. Aviation Training Forms (ATF's) for each student in the control and experimental groups were copied and mailed to the researcher at the Naval Postgraduate School. The raw data was then transferred to computer storage for analysis. The instructor's evaluation

of each maneuver was recorded along with the total grades for each flight. Data was obtained from the following syllabus flights: Familiarization stage checkride (FAM-13) and the Basic Instrument stage (BI-1 through BI-12), which included the end of stage checkride, BI-12.

The student is evaluated on various items during the Basic Instruments stage. Some of the graded items, such as headwork or procedures, would not have been affected by the treatment. Ten maneuvers were selected which were related to the treatment lecture:

1. Basic Air Work (BAW)
2. Partial Panel
3. Unusual Attitudes (full panel)
4. Initial Climb to Altitude (ICA)
5. S-1 Pattern
6. Unusual Attitudes (partial panel)
7. Approach Pattern
8. Ground Controlled Approach Maneuver (GCA)
9. Basic Approach Configuration (BAC)
10. Penetration

Although all of the maneuvers could have been affected by the treatment, the ones most likely to show improvement were BAW, Partial Panel, and the two Unusual Attitude categories. Comparison of data between the experimental and control groups was made using the mean grade or Grade Point Average (GPA). The mean grade was computed and compared in a variety of different forms in order to detect the effects of the treatment:

1. Overall Basic Instrument stage GPA.
2. End of stage checkride (BI-12) GPA.
3. Simulator events GPA and aircraft events GPA.
4. Individual maneuver mean grades.
5. Individual flight mean grades.

Analysis was conducted on the data from a total of 2480 events (simulator and aircraft flights) completed by the two

groups. This data included 16,790 separate evaluations of student performance on the various maneuvers. Since some data on individual flights was missing due to administrative problems, separate analysis was performed using only students whose file was complete and again using all students which included those with missing ATF's. No significant difference was found between the two methods of analyzing the data. The students were evaluated by 128 instructors, 124 having trained students in both groups.

C. ANALYSIS OF DATA

The environment of this study must be considered when evaluating the results in order to understand the limitations of the research design. This experiment was conducted in an operational training system which is committed to the goal of producing graduates on a fixed schedule. The difficulties attendant to conducting research within ongoing military training programs are well documented in the literature (see Chapter III for a complete discussion of the problems). In order to not interfere with ongoing training programs, the data was collected from available records. The sensitivity of the data is therefore limited by the operational requirements of the training system which must take priority over research considerations.

Analysis of variance and t-tests performed on the Familiarization stage checkride (FAM-13) performance revealed no statistically significant difference between the groups with regard to mean grades. This finding supported the hypothesis that any performance differences between the control and experimental groups on the Basic Instrument stage checkride would be a function of the experimental treatment rather than initial flight skill differences. This conclusion is supported further by the data presented earlier in Table I in Chapter IV regarding group demographic data. See Table II .

TABLE II

FAMILIARIZATION STAGE CHECKRIDE GRADES

GROUP	N	MEAN	SD	t	p<
CONTROL	97	3.003	.076	.412	.681
EXPERIMENTAL	87	3.007	.077		

Statistical analysis of the Basic Instrument stage checkride (BI-12) indicated no statistical difference between the two groups. At the time of preparation of this report, 87 students in the experimental group had completed the checkride as opposed to 97 for the control group. Delays in training caused by three hurricanes and the awarding of a new maintenance contract for the aircraft prevented some of the students in the experimental group from completing the Basic Instruments stage prior to the writing of this report. The inclusion of the remaining checkride grades is not likely to change the average grade enough to cause a statistically significant difference between the groups See Table III .

TABLE III

BASIC INSTRUMENT STAGE CHECKRIDE GRADES

GROUP	N	MEAN	SD	t	p<
CONTROL	97	3.058	.090	.589	.557
EXPERIMENTAL	86	3.051	.086		

The students' overall performance on the ten selected maneuvers in the Basic Instruments stage was compared between the two groups. Again, no statistical difference between the mean grades of the two groups was determined. Further, flight by flight comparisons between the two groups revealed no statistical differences. See Table IV .

TABLE IV

COMPOSITE BASIC INSTRUMENT STAGE GRADE POINT AVERAGES

FLIGHT	CONTROL GROUP			EXPERIMENTAL GROUP			t	p<
	MEAN	SD	N	MEAN	SD	N		
1	3.079	.103	100	3.092	.089	97	0.86	.392
2	3.086	.099	100	3.083	.097	97	0.21	.833
3	3.060	.085	100	3.050	.090	97	0.77	.443
4	3.057	.075	100	3.032	.081	97	2.39	.018
5	3.042	.074	100	3.028	.076	94	1.29	.195
6	3.043	.067	98	3.037	.082	96	0.62	.534
7	3.055	.073	94	3.062	.081	84	0.60	.548
8	3.065	.075	100	3.055	.075	95	0.95	.343
9	3.107	.074	97	3.096	.080	93	1.01	.316
10	3.062	.069	97	3.058	.068	87	0.48	.631
11	3.060	.068	97	3.073	.072	86	1.22	.223
12	3.058	.090	97	3.051	.086	86	0.59	.557
COMPOSITE	3.063	.046	100	3.056	.049	97	1.23	.221

Basic instrument training is conducted in both simulators (eight events) and in the aircraft (four flights). Analysis of the performance of the students in the simulator and the aircraft was performed to ascertain any differences between the groups in these categories. Since the aircraft

flights follow the simulator events in sequence, higher performance could be expected in the aircraft due to learning curve effects. Indeed, this was the case in both groups. However, comparison of the two groups revealed no statistically significant difference in overall performance in either the simulators or the aircraft portions of the syllabus. Further analysis of each individual maneuver did reveal statistically significant differences between the two groups for Basic Air Work (BAW). BAW refers to the overall ability of the student to fly the aircraft in balanced flight, precisely trimmed , throughout all phases of flight. The experimental group's mean BAW grade in the simulator was 3.044 while the control group's mean was 3.150; the difference was statistically significant at the $p<.001$ level. However, in the aircraft the order of mean grades was reversed: 3.118 for the control group and 3.158 for the experimental group. This could possibly have occurred because the P.A.T. principle's emphasis on trim would be more apparent in flight as opposed to the simulator. Even the most sophisticated simulators are not as sensitive to trim as the aircraft and increased emphasis on trimming might prove to be counter productive in the simulator. Nevertheless, the reversal of trends between the two groups in the aircraft and simulator tends to weaken the significance of the difference between groups on this maneuver. See Table V .

The number of unsatisfactory flights was also compared between the two groups. There were no unsatisfactory flights flown by the control group. In the experimental group, on the other hand, two unsatisfactory flights were registered. Unsatisfactory flights result in the student being awarded extra training flights prior to progressing in the syllabus and thus result in a longer time to train. The two unsatisfactory flights out of 2296 is not statistically significant however and could have occurred in the experimental group by

chance. The hypothesis that the treatment would cause a reduction in the number of unsatisfactory flights cannot be proven by the research data.

The preponderance of statistical evidence from the data indicates that there was no difference in the performance of the two groups. This would imply that the treatment had no measured effects. There is always the possibility, however remote, that the analysis may have failed to detect a true difference. We cannot know what would have resulted in an experiment if the treatment had been more powerful or sources of random error had been controlled, or suppresser variables had been measured, or an analysis with greater statistical power had been used. The fact that statistical significance was not obtained indicates that if true differences existed, they were small.

TABLE V

BASIC INSTRUMENT MANEUVER GRADES

MANEUVER	CONTROL GROUP MEAN	SD	N	EXPERIMENTAL GROUP MEAN	SD	N	t	p<
BAW	3.140	.564	1196	3.076	.585	1110	2.70	.007
SIM	3.150	.605	808	3.044	.620	766	3.44	.001
AIRCRAFT	3.118	.467	388	3.158	.465	344	1.15	.250
PARTIAL PANEL	3.143	.485	586	3.144	.537	543	0.01	.992
SIM	3.214	.501	294	3.198	.561	283	0.37	.712
AIRCRAFT	3.072	.459	292	3.085	.507	260	0.32	.747
UNUSUAL ATT (Full Panel)	3.092	.386	889	3.079	.351	824	0.75	.454
SIM	3.095	.432	502	3.100	.374	481	0.16	.871
AIRCRAFT	3.087	.317	387	3.050	.317	343	1.60	.109
ICA	3.125	.408	1092	3.120	.384	1016	0.31	.755
SIM	3.173	.469	705	3.162	.436	671	0.43	.664
AIRCRAFT	3.038	.241	387	3.038	.232	345	0.04	.966
S1 PATTERN	3.038	.464	793	3.043	.433	738	0.24	.809
SIM	2.994	.483	501	3.029	.471	476	1.16	.247
AIRCRAFT	3.113	.419	292	3.069	.356	262	1.32	.189
UNUSUAL ATT (Part Panel)	3.044	.283	489	3.030	.270	448	0.88	.377
SIM	3.056	.271	197	3.032	.272	188	0.86	.387
AIRCRAFT	3.037	.290	292	3.027	.270	260	0.44	.656
APPROACH	3.067	.476	783	3.075	.488	721	0.29	.771
SIM	3.002	.485	396	3.040	.517	377	1.03	.302
AIRCRAFT	3.134	.446	387	3.114	.454	344	0.61	.544
GCA	3.026	.431	990	3.037	.431	918	0.54	.585
SIM	2.988	.452	603	2.988	.436	573	0.02	.981
AIRCRAFT	3.085	.388	387	3.120	.413	345	1.16	.246
BAC	2.924	.313	782	2.946	.295	719	1.35	.178
SIM	2.875	.373	394	2.912	.351	376	1.40	.161
AIRCRAFT	2.974	.225	388	2.982	.216	343	0.49	.618
PENETRATION	3.064	.448	885	3.044	.459	820	0.93	.351
SIM	3.020	.491	497	2.979	.494	476	1.30	.193
AIRCRAFT	3.121	.378	388	3.135	.390	344	0.48	.629

VI. CONCLUSIONS AND RECOMMENDATIONS

A. DISCUSSION

The objective of the research was to determine the impact of a modified training lecture concerning the fundamentals of basic instrument flying on the performance of student naval aviators. The performance data obtained indicated that there was no measureable impact from the modified training. Possible interpretations of this result are:

1. The research hypothesis was false and the treatment made no difference in the students' performance.
2. Threats to experimental validity were not sufficiently controlled.
3. The measurement instrument chosen was not sensitive enough to measure a difference in performance.
4. The treatment facilitated learning but did not enhance performance.

While these alternatives are not exhaustive of the possibilities, further discussion of each and the various combinations of alternatives should help to clarify the results of this research.

The possibility that the treatment made no difference was discussed in the previous chapter. Although the preponderance of data heavily favor this alternative, it probably represents only a part of the actual true outcome of the experiment.

The experimental design was chosen to control for as many threats to internal and external validity as possible while allowing for the operational training environment. Campbell and Cook list fourteen possible threats to internal validity of which the quasi-experimental cohort design controls for all but three: history, selection and testing [Ref. 41 :pp. 227-229, 265]. History is not considered to be a threat in this research since no known events occurred during the period of training of either group that could have significantly affected their training in relation to

the other group. One might argue that the three hurricanes which caused delays in some of the students training for the experimental group could have affected their performance. However, the training command has procedures in effect which compensate for unscheduled delays in training allowing a student to get up to speed before progressing in the syllabus. Selection has been ruled out as a threat to validity due to the demonstrated homogeneity of the two groups (see Chapter IV, Section B). Testing is the effect of a pretest on posttest performance. This is not considered a problem in this research as the two are independent of one another, one being a Familiarization stage checkride and the other a Basic Instruments stage checkride. Consequently, all known threats to internal validity were controlled or noted and taken into consideration.

In regard to external validity, this pilot training facility and curriculum are very similar to the rest of the Naval Air Training Command. The results of this study could be directly applied to other areas of the training command with the expectation of similar outcomes.

The possibility that the subjective grading method was not sensitive enough to measure any difference caused by the treatment cannot be discounted. A thorough discussion of the logic behind the measurement device used was presented in Section F of Chapter IV. Previous studies have demonstrated the difficulties that exist in obtaining statistically reliable measures of trainee performance where reliance is placed on subjective checkpilot evaluation [Ref. 10 :p.18]. Nevertheless, no other measurement device was feasible, so the data must be interpreted accordingly. At the very least, if one assumes that the measurement system used could only detect relatively large changes in performance, then the data implied only a small change in performance could have occurred.

An informal survey of the students and instructors indicated that the training did facilitate the students' understanding and learning of basic instrument fundamental skills. In other words, the students in the experimental group were able to learn the basic instrument fundamentals more quickly and with less effort. However, this did not translate into higher performance because the control group students simply exerted more effort to achieve the same skill level. It must also be noted that the individual flight instructors are also teaching the students while evaluating them and the instructors will attempt to bring all students up to an acceptable level of proficiency. Perhaps an experiment designed to test trials to mastery could have better detected any impact of this training program, although this was not feasible under current training conditions.

Other researchers have found that sometimes a control group will attain equal levels of performance with an experimental group afforded more training. For example, Gerlach found in a study of Air Force undergraduate pilot training that a control group that was not afforded sophisticated training did just as well as the experimental groups that did have the more advanced training [Ref. 34 :p.23]. Flight training must also develop judgment, the ability to analyze flying tasks and the ability to make autonomous decisions. An instructional treatment which offers the possibility of attaining a high level of perceptual motor skills along with a high level of generic cognitive skills would appear to be preferable.

B. CONCLUSIONS

On the basis of the results of this study it is concluded that the modified basic instrument training did not improve the performance of student naval aviators. In addition, the time to train the students was not shortened. However, the modified lecture and training did improve their

understanding of basic instrument fundamentals, making them better educated and possibly safer aviators. The training may also have enabled the experimental group aviators to learn the complex motor skills required for instrument flying in an easier, more efficient manner than their predecessors.

C. RECOMMENDATIONS

Based on the findings from this research the following recommendations are offered:

1. The modified Basic Instruments lecture should be continued as part of the syllabus. The probable benefits in affording the student aviator with additional information and training far exceed the small costs involved.
2. The computerized scan training program proposed by Commander Spahr should be developed and implemented on a trial basis. This is a low cost program which could prove beneficial to student aviator training. See Appendix F for a detailed explanation of the scan training program.
3. Continued efforts to seek possible improvements in pilot training techniques should be encouraged. Although the current training system has proven to be quite adequate in producing skilled aviators, there is always a need for improved efficiency considering the enormous training costs involved.

When this research was begun, the proposed scan training computer program was a significant part of the training modification. The inability to test the scan trainer's effects certainly diminished the optimistic performance projections of Commander Spahr. Perhaps the synergistic effects of the scan trainer and the coordination exercises would have resulted in detectable performance improvement. Before the student aviator completely comprehends what a

scan pattern is, he must try to apply the verbal description in training manuals to actual application in the cockpit. Sometimes this results in the student adopting poor scanning techniques. The scan trainer has the potential to establish the proper techniques prior to the student's first flight. Further investigation into the possibilities of a scan trainer should be conducted.

As can be seen from this research, a small training modification can equal only a small change in performance, which may be undetectable using the established subjective norm referenced grading criteria. Since even small improvements in training methods are desirable, some method of validating the effects of proposed improvements is needed. One possibility is the development of sensitive objective measurement techniques for use in the simulators. The existing computers of the simulator could be programmed to record and compare to baseline criteria the flight path, control inputs, performance indications, etc., of the student's attempts to fly a prescribed maneuver. Deviations from the correct execution of the maneuver could then be converted to an objective scoring of the student's performance. The objective measures of performance could be incorporated into the established grading system in addition to their use for training improvement research. The added benefits from routine use of the objective performance measurement system would help to justify the development costs. Further research in this area is recommended in order to facilitate continued efforts to improve aviation training.

APPENDIX A

INDIVIDUAL DEMOGRAPHIC DATA

STUDENT	GROUP	DEGREE	SEX	AQT	FAR	SOURCE	AGE	ACADEMIC
1	C	S	M	.	.	FO	21	41
2	C	S	M	.	.	FO	21	54
3	C	S	M	.	.	FO	23	41
4	C	S	M	.	.	FO	22	55
5	C	S	M	.	.	FO	22	43
6	C	S	M	6	8	NA	24	51
7	C	S	M	5	9	DP	25	35
8	C	S	M	4	6	MC	23	66
9	C	S	M	5	7	MC	25	44
10	C	S	M	5	8	DP	23	41
11	C	A	M	7	5	AO	23	47
12	C	S	M	5	9	AO	24	38
13	C	A	M	5	7	MC	24	47
14	C	S	M	5	7	MC	28	41
15	C	A	M	3	3	AO	24	33
16	C	S	M	7	7	AO	27	60
17	C	A	F	5	3	AO	23	49
18	C	S	M	6	8	AO	24	56
19	C	S	M	3	8	AO	27	50
20	C	S	M	4	9	DP	25	29
21	C	A	M	7	9	NR	24	59
22	C	S	M	4	6	OC	26	42
23	C	A	M	5	6	AO	23	50
24	C	S	M	5	6	NA	26	54
25	C	S	M	4	9	DP	24	60
26	C	S	M	7	9	DP	23	59
27	C	A	M	4	5	DP	24	31
28	C	S	M	5	7	AO	23	46
29	C	A	M	6	7	DP	23	41
30	C	S	M	5	8	DP	23	55
31	C	S	M	5	8	AO	27	67
32	C	A	M	6	6	AO	24	49
33	C	A	M	5	8	DP	23	58
34	C	S	M	7	7	AO	25	61
35	C	A	M	5	8	MC	24	36
36	C	A	M	5	6	OC	26	28
37	C	S	M	5	9	CG	25	40
38	C	S	M	7	6	NA	23	61
39	C	S	M	7	7	MC	25	63
40	C	S	M	.	.	FO	21	26
41	C	S	M	.	.	FO	22	23
42	C	S	M	.	.	FO	26	58
43	C	S	M	.	.	FO	22	47
44	C	S	M	6	5	CG	26	53
45	C	S	M	5	9	MC	23	59
46	C	A	M	5	6	MC	25	61
47	C	S	M	6	9	NR	26	59
48	C	S	M	5	6	AO	24	52
49	C	S	M	7	6	AO	25	44
50	C	S	M	5	8	MC	27	41
51	C	A	M	5	6	AO	23	37
52	C	S	M	6	8	NA	23	62
53	C	S	M	6	6	MC	25	48
54	C	S	M	9	9	NR	23	59
55	C	S	M	6	6	CG	25	53
56	C	S	M	5	9	MC	24	51
57	C	S	M	4	6	NR	24	46
58	C	S	M	6	9	CG	24	59

STUDENT	GROUP	DEGREE	SEX	AQT	FAR	SOURCE	AGE	ACADEMIC
59	C	S	M	7	9	MC	27	59
60	C	S	M	5	5	MC	24	49
61	C	S	M	5	6	NA	24	30
62	C	S	M	6	8	MC	27	36
63	C	S	M	5	3	AO	23	38
64	C	A	M	5	9	NR	23	54
65	C	S	M	5	9	AO	26	63
66	C	S	M	6	9	AO	23	52
67	C	A	M	6	8	DP	28	60
68	C	A	M	4	8	DP	23	38
69	C	A	M	3	6	MC	25	52
70	C	S	M	5	8	AO	23	31
71	C	A	M	5	5	DP	23	48
72	C	S	M	4	4	AO	26	50
73	C	S	M	5	9	MC	26	36
74	C	S	M	5	6	OC	24	56
75	C	S	M	5	7	AO	25	45
76	C	S	M	5	7	AO	24	42
77	C	S	M	5	8	NR	25	44
78	C	S	M	4	5	MC	26	57
79	C	A	M	8	6	AO	24	53
80	C	S	M	6	9	DP	23	65
81	C	S	M	4	7	MC	25	50
82	C	S	M	4	8	DP	23	46
83	C	A	M	5	6	AO	23	45
84	C	S	M	5	8	AO	25	44
85	C	S	M	6	9	AO	26	44
86	C	A	M	5	8	AO	24	56
87	C	A	F	7	9	NR	25	30
88	C	A	M	4	7	OC	27	46
89	C	S	M	4	5	DP	23	33
90	C	S	M	7	9	AO	23	65
91	C	A	M	5	8	MC	26	21
92	C	A	M	5	5	AO	24	44
93	C	S	M	5	9	MC	24	57
94	C	S	M	5	3	NR	23	44
95	C	S	M	5	4	CG	30	35
96	C	S	M	5	7	MC	25	48
97	C	S	M	5	5	MC	24	53
98	C	S	M	9	8	NR	25	62
99	C	S	M	5	6	NR	24	39
100	C	A	M	4	5	AO	24	41

STUDENT	GROUP	DEGREE	SEX	AQT	FAR	SOURCE	AGE	ACADEMIC
1	E	S	M	5	8	AO	23	28
2	E	S	M	7	9	NR	22	59
3	E	S	M	7	6	NR	23	38
4	E	S	M	3	6	NR	23	46
5	E	A	M	6	5	CG	30	48
6	E	S	M	7	7	AO	24	50
7	E	S	M	6	8	MC	25	59
8	E	A	M	4	7	NR	24	51
9	E	A	M	6	6	AO	25	48
10	E	A	M	5	6	AO	27	49
11	E	S	M	.	.	FO	28	41
12	E	S	M	5	7	AO	25	49
13	E	S	M	.	.	FO	26	48
14	E	S	M	5	8	NR	22	42
15	E	S	M	5	9	AO	28	62
16	E	A	M	5	7	AO	25	53
17	E	S	M	5	6	MC	24	47
18	E	S	M	7	9	AO	24	59
19	E	A	M	4	9	NR	23	60
20	E	S	M	6	7	NR	22	54
21	E	S	M	5	9	AO	25	59
22	E	S	M	5	9	NR	22	36
23	E	S	M	7	7	AO	23	58
24	E	S	M	5	7	AO	27	45
25	E	S	M	5	9	AO	26	33
26	E	S	M	4	7	DP	24	39
27	E	A	M	5	5	AO	26	32
28	E	A	M	4	7	MC	25	53
29	E	S	M	.	.	FO	29	43
30	E	S	M	5	7	NR	22	31
31	E	S	M	5	7	AO	28	40
32	E	S	M	3	8	NR	22	45
33	E	S	M	7	9	NR	22	43
34	E	A	M	6	7	NR	22	29
35	E	S	M	5	6	AO	27	35
36	E	S	M	7	9	DP	24	63
37	E	A	M	5	7	AO	24	33
38	E	S	M	4	4	NR	22	38
39	E	S	M	9	9	NR	23	54
40	E	S	M	6	9	NR	23	62
41	E	S	M	3	6	AO	22	55
42	E	S	M	3	9	AO	24	42
43	E	A	M	5	5	AO	26	53
44	E	S	M	4	6	MC	30	20
45	E	A	M	5	8	AO	23	54
46	E	S	M	7	7	NR	22	61
47	E	A	M	4	6	MC	26	38
48	E	A	M	7	9	NR	25	35
49	E	S	M	5	9	AO	23	37
50	E	S	M	5	9	NR	24	64
51	E	A	M	6	7	MC	25	51
52	E	S	M	8	9	NR	22	51
53	E	A	M	8	9	MC	25	43
54	E	S	M	3	7	MC	27	43
55	E	S	F	7	5	AO	22	43
56	E	S	M	3	6	MC	26	41
57	E	S	M	4	6	NR	23	50
58	E	A	M	6	8	NR	23	64
59	E	S	M	6	6	NR	22	39
60	E	S	M	5	9	AO	25	54
61	E	S	M	5	6	AO	24	55
62	E	S	M	6	6	NR	22	47
63	E	A	M	6	7	NR	23	58
64	E	A	M	5	7	NR	22	42
65	E	S	M	5	5	AO	23	28
66	E	A	M	4	6	NR	23	36
67	E	S	M	5	8	AO	25	54
68	E	A	M	6	8	NR	23	46

STUDENT	GROUP	DEGREE	SEX	AQT	FAR	SOURCE	AGE	ACADEMIC
69	E	S	M	5	6	AO	25	44
70	E	A	M	3	7	AO	23	36
71	E	S	M	4	6	MC	26	50
72	E	A	M	5	9	AO	25	39
73	E	S	M	5	3	AO	23	49
74	E	S	M	9	9	NR	22	61
75	E	S	M	4	6	NR	23	50
76	E	S	M	5	9	AO	23	48
77	E	A	M	6	8	NR	22	44
78	E	S	M	5	9	AO	23	52
79	E	A	M	4	9	MC	25	56
80	E	A	M	4	8	MC	24	28
81	E	S	M	4	6	NR	22	46
82	E	A	M	4	6	AO	23	45
83	E	A	M	5	9	MC	29	58
84	E	A	M	5	7	NR	23	46
85	E	S	F	5	4	CG	26	37
86	E	S	M	4	4	NR	27	48
87	E	S	M	5	9	NR	22	56
88	E	S	M	6	9	AO	25	47
89	E	S	M	7	7	NR	23	44
90	E	A	M	7	5	DP	24	63
91	E	A	M	5	6	AO	26	28
92	E	S	M	5	6	MC	24	35
93	E	S	M	5	9	AO	26	62
94	E	A	M	5	6	NR	24	38
95	E	A	M	5	7	NR	22	40
96	E	A	M	6	7	AO	23	43
97	E	S	M	4	7	DP	24	29
98	E	A	M	5	6	OC	25	26
99	E	S	M	4	9	DP	23	52
100	E	S	M	6	9	NR	24	51

GROUP
C = CONTROL
E = EXPERIMENTAL

DEGREE
A = BACHELOR of ARTS
S = BACHELOR of SCIENCE

SOURCE
AO = AOCS
CG = COAST GUARD
DP = DIRECT PROCUREMENT
FO = FOREIGN
MC = MARINE CORPS
NA = NAVAL ACADEMY
NR = NROTC
OC = OCS

APPENDIX B

MODIFIED LECTURE ON ATTITUDE INSTRUMENT FLIGHT FUNDAMENTALS

Building P.A.T. Reflex Coordination

The P.A.T. principle is used in essentially all aircraft transitions. You must set power, applying simultaneous, proportional rudder pressure to maintain balanced flight, while changing the maneuver attitude using coordinated rudder and stick, then trim to support the newly developed attitude. The P.A.T. transition must be performed in the following sequence to be effective, and before scan begins.

START	POWER	STOP		
	ATTITUDE	START	TRIM	SCAN

Although power and attitude changes start almost simultaneously, you must lead with power control lever(PCL) movement. Match any power change with simultaneous, proportional rudder pressure while setting the new attitude using coordinated rudder and stick. Normally, power and attitude change at the same rate. Except for performance corrections you should complete both power and attitude changes at the same time. After the miniature airplane maneuvering attitude is set on the gyro and balance of flight is checked using the ball, trim in sequence rudder, elevator and aileron to relieve primary control surface pressures generated from setting the desired power and attitude combination.

Now the secret! To improve your motor skill coordination, the P.A.T. principle can be practiced on the ground quickly achieving smooth disciplined hand(s)/feet

coordination. Simply, sit in a chair with your toes against a firm surface and simulate PCL power addition/reduction with simultaneous, proportional toe pressure squeezing against a fixed object. Then, with power set, trim deliberately to relieve rudder pressures. Example: PCL power addition normally requires simultaneous, proportional right rudder toe pressure to correct for engine torque induced yaw. Follow this with your left hand turning the rudder trim knob slightly clockwise simulating relief of right rudder pressure as your right toes relax pressure against the rudder pedal. The left rudder is required with power reduction with rudder trim applied in a counter-clockwise direction. You should practice this exercise in a series concentrating on smooth, coordinated power, rudder and trim reflex execution throughout any P.A.T. transition.

In the same manner, practice turn entry/exit by simulating movement of a "stick" in the direction of turn entry/exit applying simultaneous, proportional and deliberate rudder pressure in the direction of turn to develop a balanced turning attitude. Concentration on smooth, proportional rudder displacement, rudder leading, coordinated with stick for both turn entry and exit will assist you in developing the necessary reflexes to achieve and maintain continuous balanced instrument flight. Use of coordinated, assertive rudder and timely, systematic trim is essential for precise instrument flying.

PRACTICAL AERODYNAMIC RELATIONSHIPS

The P.A.T. principle transition diagrammed Fig 1 describes the timing and coordination required between power and attitude, supported by trim. From a state of balanced flight, power and attitude must change simultaneously, leading with power. The rate of power change should be matched by a similar rate of change in attitude. Ideally

both power and attitude should complete their changes at the same time producing the desired maneuvering attitude and performance.

Coordination of primary controls as well as rudder, elevator and aileron trim compensating for P.A.T. maneuvering attitude and performance changes requires thorough understanding of the trim diagram (Figure 2), and a good deal of practice to become smooth, timely and accurate. A level flight P.A.T. principle power increase requires simultaneous, proportional right rudder and down elevator supported with trim to compensate for the power increase. Power reductions require coordinated left rudder and up elevator supported with trim to compensate for the power loss. Similarly, Figure 2 shows that accelerating airspeed requires left rudder and down elevator trim while a deceleration requires right rudder and up elevator trim. Remember, power and airspeed operate vectorally. The power airspeed vector sum may change substantially during any P.A.T. transition. From a state of balanced flight, an initial rudder requirement resulting from a power change may quickly reverse as airspeed changes from that at which the aircraft was last trimmed. Knowing which direction the ball will move in each circumstance will improve your overall balanced attitude control and assist in planning precise aircraft maneuvers.

FLYING ATTITUDE INSTRUMENT FLIGHT

To fly consistently accurate attitude instrument flight, you must set and trim a precise, planned and balanced attitude during P.A.T. This means that you must know or estimate the power and maneuvering attitude which will give the desired performance. Aircraft instrument maneuvering attitudes must be treated as a three dimensional problem. That is, both nose and wing position must be set on the attitude

gyro using the miniature airplane, and balance ball must be simultaneously centered with rudder toe pressure. You must then relieve primary control surface pressures with trim before starting your instrument scan. The scan pattern begins only after the balanced P.A.T. principle transition maneuver is complete.

Knowing where the level flight attitude (LFA) is and how to achieve it is the key to attitude instrument flight. The LFA nose attitude for any airspeed can be estimated referring to Figures 3 and 4. Figure 3 shows the nose attitude for selected airspeeds in wings level, balanced, level flight. Because airfoil effectiveness improves with increasing airspeed, you can see why the slope of the curve in Figure 3 is shallower at higher speeds. Also, the nose pitch required to produce LFA in any other configuration can be determined from a similarly constructed curve.

Figure 4 illustrates the ratio one over the cosine of the angle-of-bank. Aerodynamically, this represents the special relationship between the angle-of-bank and the nose attitude (G's) required to give level flight. Remember, Figure 4 is valid for any flying airspeed and flight configuration. Now, knowing the LFA for straight and level flight from Figure 3 and applying the estimated pitch correction needed for a specific angle-of-bank, you can plan or estimate the nose attitude required to produce level flight in a turn, regardless of airspeed, configuration or angle-of-bank.

Also, Figure 4 suggests that if you raise the aircraft nose higher than the LFA or at a rate faster than that required by the instantaneous angle-of-bank, the aircraft will climb and decelerate. If you raise the nose slower than the instantaneous angle-of-bank described in Figure 4 or position it lower than the attitude required, the aircraft will descend and accelerate. Understanding the LFA principle you will quickly learn attitude instrument flight control

and unusual attitude recoveries. Clearly, the time you spend practicing motor skill exercises and studying practical aerodynamic relationships will pay immediate dividends in better control.

FULL PANEL UNUSUAL ATTITUDE RECOVERIES

A full panel unusual attitude must be recovered to balanced, level flight by maneuvering the miniature airplane on the attitude gyro. This means flying the nose attitude to the level flight attitude (LFA) for the airspeed at time of recovery, leveling the wings and ensuring that balance of flight is restored using coordinated rudders. A practical aerodynamic review may help you understand how airspeed and aircraft attitude combine to aid or hinder a smooth, efficient recovery. Use Figure 5 to help explain what stick forces should be anticipated at various times during these maneuvers. Remember, LFA for any airspeed less than 150 kts is found above the gyro horizon interface. LFA for any airspeed greater than 150 kts is found below the horizon interface. In the following examples, use your hand or a model airplane to help visualize the maneuver and recovery.

A. Nose Low Maneuvers - Aircraft trimmed for 150 kts

1. At very slow airspeed (70-130kts) with the balance ball to the right, the aircraft will pitch nose down very rapidly if the stick is released. This happens regardless of aircraft wing attitude. Also, the plane will exhibit a significant left yaw and proverse roll. You must stop the nose from falling by using back stick pressure. Then level the wings with coordinated rudder and aileron, maintaining a fixed nose postion. Then, deliberately raise the nose to the LFA based on current airspeed. Use Figure 3 to estimate LFA and crosscheck the nose attitude position with the VSI and altimeter.

2. At very fast airspeeds (balance ball left) the aircraft nose will tend to pitch up if stick pressure is released and will exhibit a right yaw and proverse roll. You must use forward stick to control the nose pitching moment (avoiding a rolling pullout) while rolling wings level with coordinated rudder and aileron then return the ball to a balanced position. Now, deliberately fly the nose to the LFA based on airspeed and crosscheck the nose attitude with the VSI and altimeter. Note: when nose low with airspeed above 200 kts, set PCL idle till approaching 155 kts then smoothly reset cruise power

B. Normal Nose High

1. With airspeed fast, say 170-210 kts, the nose will tend to rise as a function of airspeed above normal cruise speed. Also, the aircraft should exhibit a right yaw and proverse roll. If the aircraft is in a left banking attitude, right yaw and proverse roll will tend to slow the roll rate. In a right turn, right yaw and proverse roll will tend to increase the roll rate and angle of bank. You must stop the nose pitch up by applying forward stick pressure as necessary with coordinated rudder and aileron to hold the wings at a constant angle of bank while flying the nose toward the LFA based on the airspeed at recovery. As the nose attitude approaches the estimated LFA roll aircraft wings level with coordinated rudder and aileron. Remember, airspeed will normally decelerate with a nose high attitude; therefore, airspeeds above 200 kts do not require PCL reduction. LFA stick pressure requirements will reduce as airspeed approaches 150 kts, Figure 5 refers.

1. With airspeed 170-100 kts, deceleration should occur with left yaw proverse roll developing a airspeed slows through 150 kts. Though you must apply some back stick pressure in order to prevent the nose from falling uncontrolled, you must support the nose with stick pressure and fly it toward the LFA based on airspeed. As LFA is approached, you must roll the aircraft wings level using coordinated rudder and aileron then crosscheck the VSI and altimeter to confirm the correct nose attitude.

C. Extreme Nose High

1. Aircraft fast, say 170-210 kts, in left bank. While rolling toward 90 degrees angle of bank, a right yaw and proverse roll factor will slow the nose as it is flown toward the horizon. Deliberate left rudder will be necessary to fly the nose below the horizon followed by coordinated right rudder and aileron to roll wings level. Then, using rudders to return the ball to balanced flight, raise the nose to the LFA based on the airspeed at recovery. Similarly, with the aircraft in a right bank, the associated right yaw and proverse roll will accelerate the rate of roll and nose falling through the horizon. In both cases you must assertively use stick and rudder pressures necessary to maneuver the miniature airplane on the attitude gyro and smoothly, deliberately recover the aircraft to the LFA.

2. Aircraft Slow, Less Than 100 KTS IN A Right Bank. While rolling toward 90 degrees angle of bank, apply sufficient right rudder to fly the nose below the horizon. The aircraft will exhibit a left yaw and proverse roll which would help slow the nose as it falls to and through the horizon. Remember, if the stick is allowed to "float" at this very slow speed, the aircraft nose will pitch down, and depending on speed can produce negative G's during the rolling portion of the recovery. This is undesirable and can induce vertigo. You can stop this by applying some back stick pressure at speeds less than 150 kts. Once the nose has passed below the horizon, the aircraft is recovered to the LFA as described in nose low. A left banking attitude will exhibit a higher rate of left roll with the nose rapidly falling through the horizon. You should plan to prevent the nose from falling further below the horizon by using sufficient

back stick pressure to slow and stop the nose as it passes the horizon. The remaining recovery is performed just like the nose low maneuver.

PARTIAL PANEL FLIGHT

Partial panel flight is simply a refinement of full panel attitude instrument flight. The same rules of aerodynamics apply. Instruments will present their specific attitude crosscheck data with the same "LAG" as experienced in full panel instrument flight and require the same power and attitude "LEAD" to make timely, coordinated and balanced primary control surface attitude changes supported by precise trim.

Next, the mechanics of flight are precisely the same as full panel attitude instrument flight except that roll rates started by aileron deflection must be done knowing that the turn needle lags so much that a rate of roll exceeding the capacity of the rate turn gyro to display its real time value leaves the pilot with no idea of actual wing position. Also, since the turn needle is only an indicator of gyro precession due to heading change, an aircraft which is rolled into a turn without coordinated, proportional rudder will initially display a turn in the opposite direction. This phenomenon is an example of adverse yaw and produces a significant delay in presentation of accurate wing attitude information for fixed wing aircraft entering turns (FAM FTI Refers).

How to do it ... Once you have exhausted all available steps to regain full panel instrument flight and while returning the aircraft to trimmed straight and level balanced flight, shift your level flight scan (Fig 5 refers) to the turn needle and balance ball for roll and yaw. These instruments provide crosscheck data for two aircraft axes just as the attitude gyro provided status of two axes, pitch

and roll. The third partial panel axis indicator is the VSI for pitch.

The stick should be held in the same manner as in full panel instrument flight with unusual emphasis placed on immediate supporting trim to relieve the least amount of pressure developed while setting attitude with the stick and rudder. Methodical study of the turn needle and ball will lead to balanced, level wing position. Then, regular scan of the VSI and altimeter will permit timely corrections to nose attitude position and trim to produce level flight.

Flying into a level partial panel turn is an exercise in patience and discipline. Coordinated rudder lead-in and simultaneous, proportional aileron deflection is initiated to reduce adverse yaw and improve turn needle accuracy. Aileron input should be limited to that amount of stick deflection which will smoothly yet slowly produce needle deflection. Since only about 3.5% of effective vertical lift is lost in a one needle width turn at normal cruise airspeed, only small stick changes supported by precise elevator trim are required. When the turn needle has moved about 30% of the distance to the desired rate turn position, smoothly return the rudder to a nearly neutral position leaving in that rudder required for balanced flight which compensates for power addition and the effects of adverse yaw. The balance ball should be centered; and rudder, elevator, aileron control pressure trimmed, to a "hands off" state.

To fly wings level from a level turn, the control process is the same. Smoothly, coordinate rudder (leading) with simultaneous proportional aileron control inputs to cause the turn needle to very slowly return toward a straight up position, zero rate of turn. As the turn needle completes 80% of its travel, you must smoothly neutralize the control inputs ensuring the turn needle has stopped at the vertical position. Ensure the rudder is trimmed to

maintain balanced flight and crosscheck the VSI for proper nose attitude. Make any necessary change in nose attitude with smooth, deliberate stick inputs supported with immediate trim to remove stick pressures. During normal partial panel flight the pilot should not attempt to hold primary control pressure in the stick as a substitute for proper trim. Trimming to maintain zero stick pressure in instrument flight is absolutely critical and highly professional. Remember, higher airspeed will produce more responsive controls and higher rates of roll.

You should not normally alter your sitting position in the seat or how you hold the aircraft stick. The left hand should be actively involved in trimming and adjusting power as required. The body should be held in the same flying position as in full panel instrument flight. There is no advantage to leaning closer to the panel. Actually, better instrument scan is gained at normal panel observation distance. The forearm should be kept firmly in contact with the kneeboard and/or thigh to minimize inadvertent stick inputs from unintentional arm/body movement. These unplanned movements lead to magnified control problems.

Physiologically, the eye is able to focus and clearly discern a visual arc of about 2-3 degrees. As an illustration, this means that if you hold a one dollar bill at instrument panel distance and look at the first digit of the serial number, you would progressively be less able to determine what the next number was beyond the one you were studying. This is important. For smooth flight, when you study the trim needle and ball position, VSI motion must be detected through peripheral vision. The eye should check and recheck the value and rate of change in the VSI. This must not lead to fixation but greater awareness and smooth control of aircraft attitude.

Finally, you must fly the aircraft using the concept of attitude instrument flight. No amount of "bumping", "rolling

and pulling", or "ratcheting" can take the place of correctly executed attitude instrument flight fundamentals. Example: If the aircraft was in level flight but now exhibits a climb on the VSI and altimeter, the aircraft nose attitude is too high. The nose attitude must be repositioned and trimmed to a slightly lower attitude in order to attain level flight. Next, the nose must be repositioned and trimmed to an attitude slightly below the current level flight attitude in order to descend. Of course if airspeed is slow the aircraft should first be accelerated to desired cruise speed during the shallow descent. Once airspeed is corrected, then descent should be further controlled with power, attitude and trim to support the maneuvering attitude.

PARTIAL PANEL UNUSUAL ATTITUDE RECOVERY

Partial panel unusual attitude recoveries can be done smoothly and consistently by applying the following practical aerodynamic principles. First, in order to maintain level flight at an airspeed less than the 150 kts trimmed airspeed, the nose must be supported with backstick pressure since elevator effectiveness is less at slower airspeeds, Figure 6 refers. The amount of stick pressure varies with airspeed. The slower the airspeed the more backstick is required to maintain the level flight attitude (LFA). The opposite stick force is necessary to maintain level flight for airspeeds greater than 150 kts. In this case, forward stick pressure must be used to prevent the nose from pitching up due to greater elevator effectiveness, Figure 6 refers. Second, once established in level flight at an airspeed less than 150 kts, the aircraft is overpowered and will accelerate toward the original trimmed cruise airspeed. Likewise, when in level flight at an airspeed greater than 150 kts the aircraft is underpowered and may be expected to

decelerate toward the original trimmed cruise airspeed. With these relationships in mind, you will be given a partial panel unusual attitude. You must hold the initial stick pressure while quickly determining nose attitude (high/low) through airspeed trend and VSI and altimeter indications. Wing attitude is seen through the turn needle position and balanced flight is complete with the ball centered. Study the following descriptions carefully! Use your hands to visualize the recovery.

If no pressure was given or found in the stick, check the current airspeed and insert elevator stick pressure you estimate is required to hold the aircraft in level flight; backstick if airspeed is less than 150 kts (Fig 7 a,c,and d) and forward stick if airspeed is greater, (Fig 7 b). Remember, the closer the airspeed is to 150 kts, the smaller the stick pressure requirement will be, Figure 6 refers. Also, if airspeed subsequently passes 150 kts accelerating or decelerating, stick pressure initially applied for level flight recovery will reverse proportional to airspeed, (Fig 7 b,c). Now with no delay and initial pressure set, use smooth, assertive coordinated rudder and aileron to center the ball and simultaneously level the wings controlling the turn needle to vertical. Then, with turn needle,ball centered, recheck airspeed;

A. If the airspeed is slowing, the nose is higher than the level flight attitude and must be repositioned to a lower attitude. So, when the airspeed is less than 150 kts decelerating, backstick must be eased momentarily to allow the nose to settle; then the stick must be eased as before to hold the nose at the slightly lower attitude. Similarly, if the airspeed is greater than 150 kts decelerating, the nose must be flown to a slightly lower attitude by using more forward stick pressure to counter the more effective elevator control.

A. If the airspeed is accelerating, the nose must be flown to a slightly higher attitude to stop the acceleration. So, if the airspeed is faster than 150 kts and accelerating, you must allow the nose to rise slightly by momentarily easing some forward stick pressure, then reposition the stick as before holding a slightly higher nose attitude. If the airspeed is more than 150 kts and decelerating, your must lower the nose attitude a small amount to return to the level flight attitude.

With airspeed stopped or nearly constant, quickly integrate the VSI into your scan. Now, using anticipatory stick pressure, adjust the nose attitude higher or lower in small attitude changes controlling the VSI to zero. When the VSI is indicating zero, the nose is in the level flight attitude and the aircraft is maintaining level flight regardless of flying speed. If the VSI shows a descent or climb, adjust the nose attitude accordingly to return to level flight.

Let's review. Take the unusual attitude. Hold the initial stick position constant. Check value/direction of airspeed and determine nose attitude. If no pressure was given, set appropriate estimated level flight attitude pressure as described by Figure 6. Fly the wings level using turn needle/ball and coordinated rudder and aileron. Recheck airspeed and stop movement adjusting nose attitude with stick pressure as necessary. Integrate the VSI in your scan and control VSI to zero using stick pressure as necessary. Remember, the VSI and turn needle lag. You must lead both the VSI and turn needle indicators with smooth, timely and specific attitude changes using assertive stick and rudder.

```
                       simultaneous
  START                proportional   STOP
|      POWER           rudder       |
|___________________________________|
  |                         gyro    |
  | Set-ATTITUDE            ball    | START TRIM    SCAN
  |_________________________________|______________________
```

FIG. 1

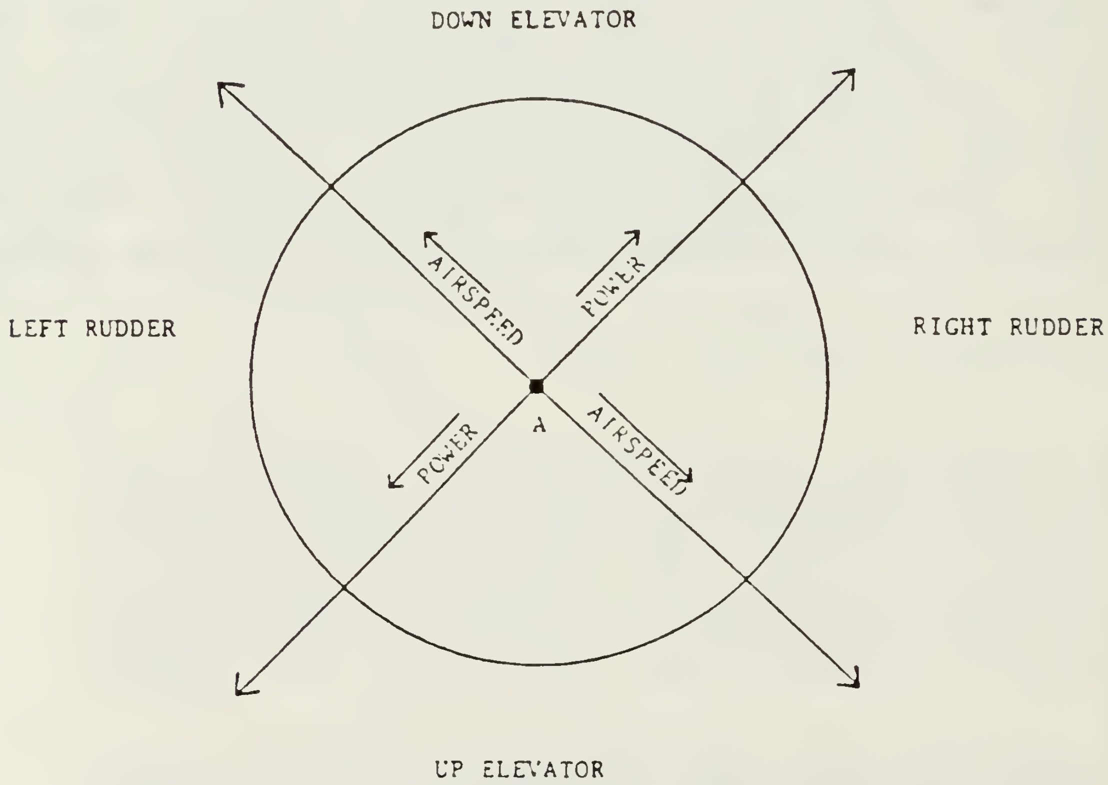


FIG. 2

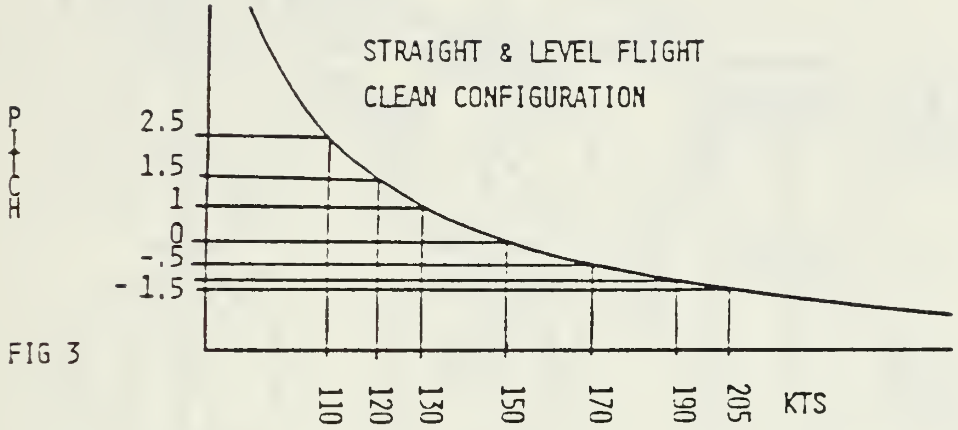

STRAIGHT & LEVEL FLIGHT
CLEAN CONFIGURATION
PITCH
2.5
1.5
1
0
-.5
-1.5
110
120
130
150
170
190
205
KTS

FIG 3

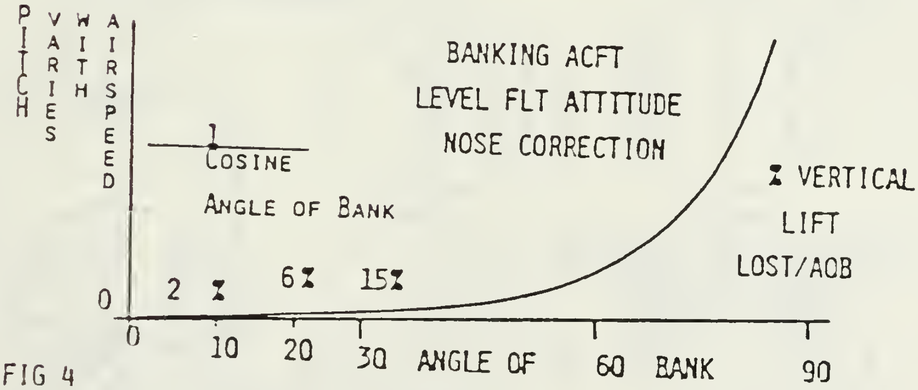

PITCH VARIES WITH AIRSPEED
BANKING ACFT
LEVEL FLT ATTTTUDE
NOSE CORRECTION
1
COSINE
ANGLE OF BANK
% VERTICAL
LIFT
LOST/AOB
2 %
6%
15%
0
0
10
20
30
ANGLE OF
60
BANK
90

FIG 4

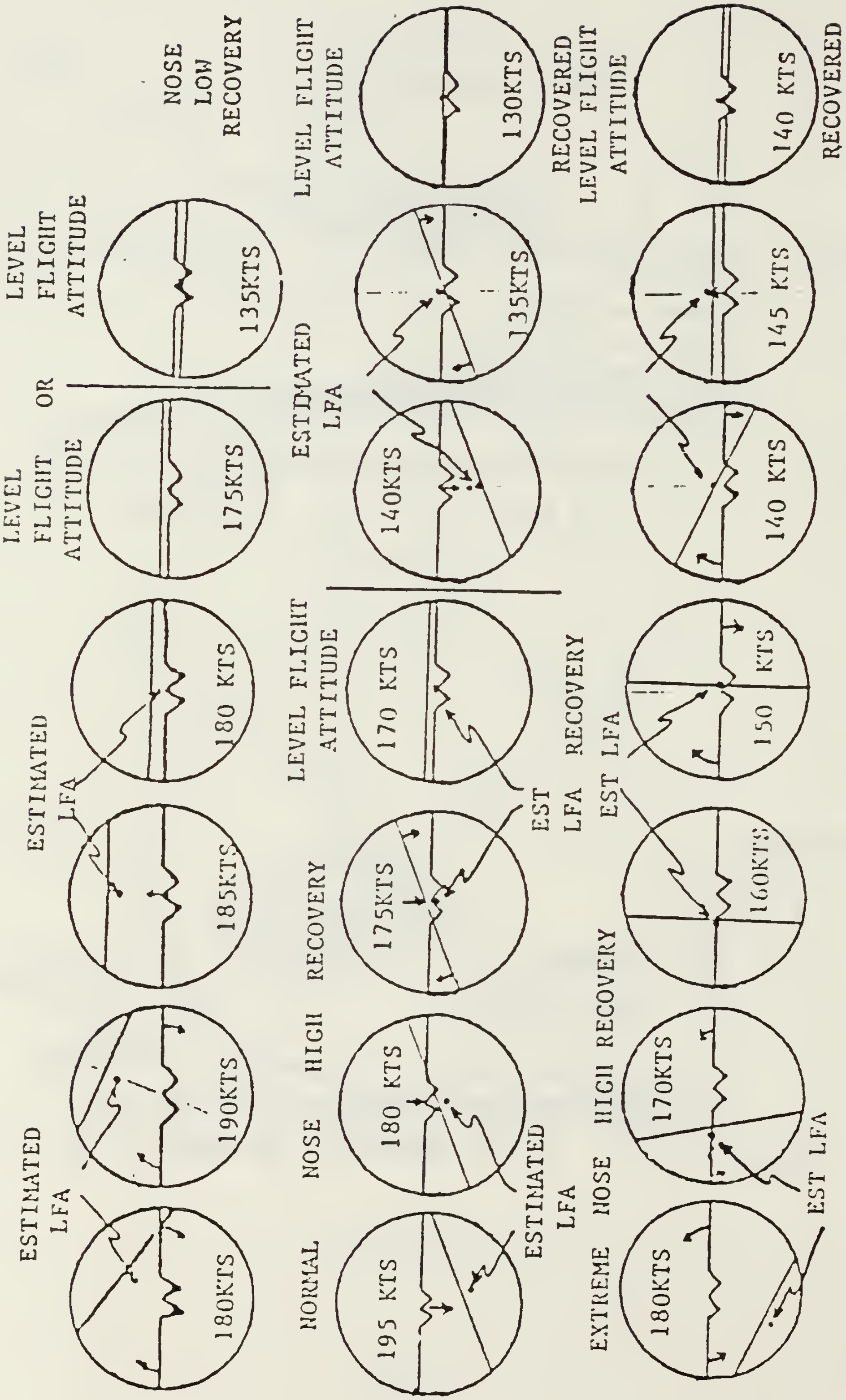
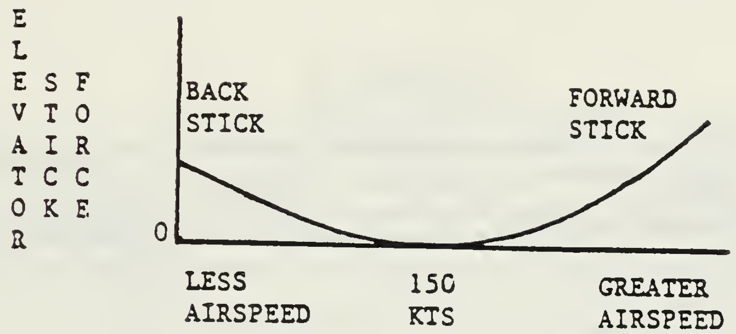
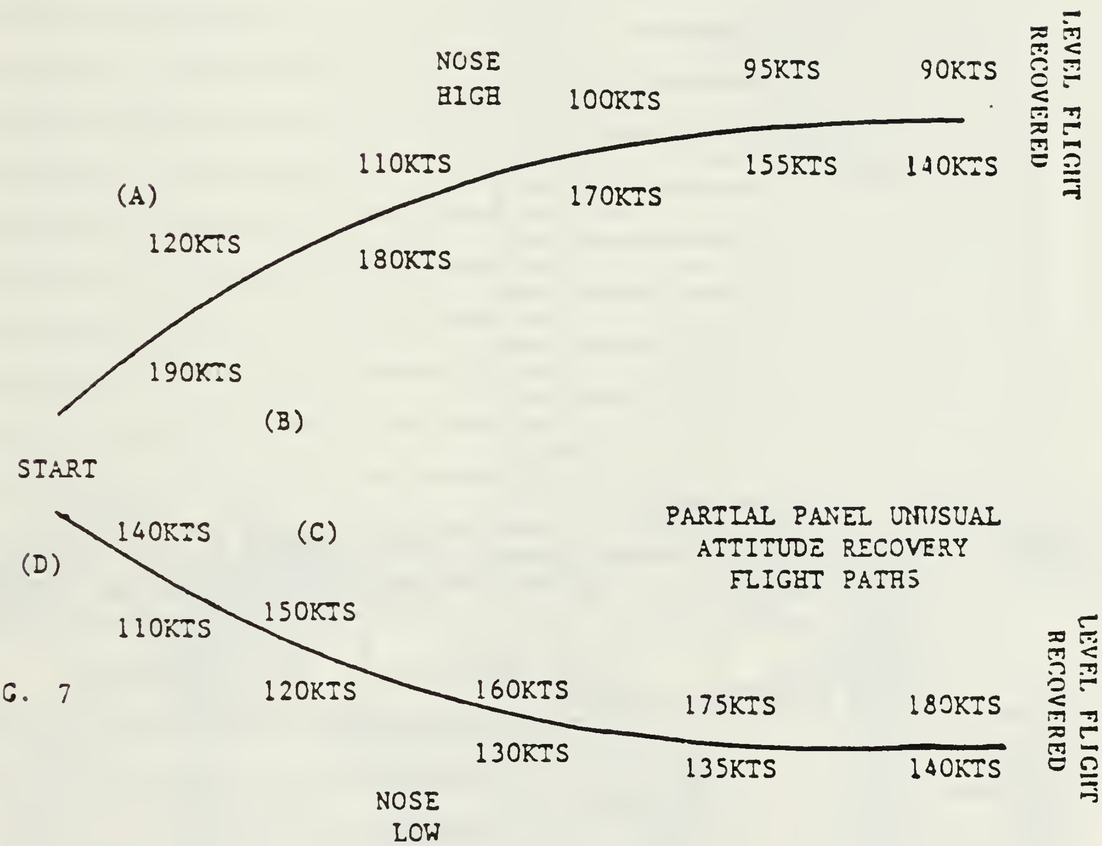

ESTIMATED LFA
180KTS
190KTS
ESTIMATED LFA
185KTS
180 KTS
LEVEL FLIGHT ATTITUDE
175KTS
OR
LEVEL FLIGHT ATTITUDE
135KTS
NOSE LOW RECOVERY
NORMAL NOSE HIGH RECOVERY
195 KTS
ESTIMATED LFA
180 KTS
175KTS
EST LFA
LEVEL FLIGHT ATTITUDE
170 KTS
140KTS
ESTIMATED LFA
135KTS
LEVEL FLIGHT ATTITUDE
130KTS
EXTREME NOSE HIGH RECOVERY
180KTS
170KTS
EST LFA
160KTS
EST LFA RECOVERY
150 KTS
140 KTS
145 KTS
RECOVERED LEVEL FLIGHT ATTITUDE
140 KTS
RECOVERED

FIG. 5

FIG. 6





PARTIAL PANEL UNUSUAL ATTITUDE RECOVERY FLIGHT PATHS

FIG. 7

APPENDIX C

AVIATION TRAINING FORMS

CNATRAINST 1542.59C

AVIATION TRAINING FORM/FAMILIARIZATION. FAM-13X	SQUADRON (VT/HT)

U	BA	A	AA	I/D		ITEM	COMMENTS
				R	1	Headwork	
				R	2	Basic airwork	
				R	3	Procedures	
				R	4	Emergency procedures	
				NG	5	Ground procedures	
				NG	6	Takeoff/Departure	
				NG	7	Course rules/Comm/IFF	
				NG	8	ICA	
				NG	9	Turn pattern	
				R	10	ATS	
				R	11	SPIN	
				R	12	HAPL	
				R	13	PPEL	
				R	14	LAPL(C)	
				R	15	PPEL(P)	
				R	16	LAPL(P)	
				R	17	Landing pattern	
				R	18	FF landings	
				R	19	NF landings	
				R	20	Waveoff	
				D	21	R/C secured for Solo flt.	
				R	22	EPL-USE	
				NG	23	OFO	

U	BA	A	AA	ITEM	FLIGHT TIME LOG											
					DATE	FLT DUR	FP	CP	SC	NIGHT	LANDINGS FIELD	LANDINGS SHIP	INST	ACT	SIM	APPROACH TYPE/NO
				TOTAL MARKS THIS FLIGHT												
				TOTAL CARRIED FORWARD	JULIAN DATE											
				CUMULATIVE STAGE TOTAL		CUM TOTAL										

CLASS NO.	WARM UP	UP	INSTRUCTOR'S SIGNATURE
AIRCRAFT T-34C	EXTRA TIME	DOWN	
	CHECK FLIGHT	SAFE FOR SOLO	INSTRUCTOR'S NAME / SSN / RANK
STAGE FAM	RECHECK	UNSAFE FOR SOLO	
	SPECIAL CHECK	COMPLETE	STUDENT'S NAME / SSN / RANK
EVENT -13X	CORRECTION	INCOMPLETE	

CNATRA 1542/270 (10-83)

AVIATION TRAINING FORM/BASIC INSTRUMENTS. BI-1S

SQUADRON (VT/HT)

PERFORMANCE APPRAISAL							COMMENTS
U	BA	A	AA	I/O		ITEM	
				P	1	Headwork	
				P	2	Basic airwork	
				P	3	Procedures	
				P	4	Emergency procedures	
				I	5	Straight and level	
				I	6	CABT	
				I	7	Constant airspeed climbs/descents	
				I	8	Trim	

U	BA	A	AA	ITEM	FLIGHT TIME LOG												
				TOTAL MARKS THIS FLIGHT	DATE	FLT DUR	FP	CP	SC	NIGHT	LANDINGS FIELD	LANDINGS SHIP	INST	ACT	SIM	APPROACH TYPE/NO
				TOTAL CARRIED FORWARD	JULIAN DATE											
				CUMULATIVE STAGE TOTAL		CUM TOTAL										

CLASS NO.	WARM UP	UP	INSTRUCTOR'S SIGNATURE
AIRCRAFT 2B-37	EXTRA TIME	DOWN	
	CHECK FLIGHT	SAFE FOR SOLO	INSTRUCTOR'S NAME / SSN / RANK
STAGE BI	RECHECK	UNSAFE FOR SOLO	
EVENT -1S	SPECIAL CHECK	COMPLETE	STUDENT'S NAME / SSN / RANK
	CORRECTION	INCOMPLETE	

CNATRA 1542/272 (10-83)

AVIATION TRAINING FORM/BASIC INSTRUMENTS. BI-2S	SQUADRON (VT/HT)

U	BA	A	AA	I/D		ITEM	COMMENTS
				P	1	Headwork	
				P	2	Basic airwork	
				P	3	Procedures	
				P	4	Emergency procedures	
				I	5	Constant rate turns	
				I	6	CRC/D	
				I	7	ICA	
				P	8	Straight and level	
				P	9	CABT	
				P	10	Constant airspeed climbs/descents	

U	BA	A	AA	ITEM	FLIGHT TIME LOG											
				TOTAL MARKS THIS FLIGHT	DATE	FLT DUR	FP	CP	SC	NIGHT	LANDINGS FIELD	LANDINGS SHIP	INST	ACT	SIM	APPROACH TYPE/NO
				TOTAL CARRIED FORWARD	JULIAN DATE											
				CUMULATIVE STAGE TOTAL		CUM TOTAL										

CLASS NO.	WARM UP	UP	INSTRUCTOR'S SIGNATURE		
AIRCRAFT 2B-37	EXTRA TIME	DOWN			
	CHECK FLIGHT	SAFE FOR SOLO	INSTRUCTOR'S NAME	SSN	RANK
STAGE BI	RECHECK	UNSAFE FOR SOLO			
EVENT -2S	SPECIAL CHECK	COMPLETE	STUDENT'S NAME	SSN	RANK
	CORRECTION	INCOMPLETE			

CNATRA 1542/273 (10-83)

AVIATION TRAINING FORM/BASIC INSTRUMENTS, BI-3S

SQUADRON (VT/HT)

PERFORMANCE APPRAISAL							COMMENTS
U	BA	A	AA	I/O		ITEM	
				P	1	Headwork	
				P	2	Basic airwork	
				P	3	Procedures	
				P	4	Emergency procedures	
				I	5	Direct to a VOR/TACAN	
				I	6	Unusual attitudes(full panel)	
				I	7	GCA maneuver	
				P	8	ICA	
				P	9	Straight and level	
				P	10	Constant rate turns	
				P	11	CRC/D	

U	BA	A	AA	ITEM	FLIGHT TIME LOG											
											LANDINGS					
				TOTAL MARKS THIS FLIGHT	DATE	FLT DUR	FP	CP	SC	NIGHT	FIELD	SHIP	INST	ACT	SIM	APPROACH TYPE/NO
				TOTAL CARRIED FORWARD	JULIAN DATE											
				CUMULATIVE STAGE TOTAL		CUM TOTAL										

CLASS NO.	WARM UP	UP	INSTRUCTOR'S SIGNATURE
	EXTRA TIME	DOWN	
AIRCRAFT 2B-37	CHECK FLIGHT	SAFE FOR SOLO	INSTRUCTOR'S NAME / SSN / RANK
STAGE BI	RECHECK	UNSAFE FOR SOLO	
EVENT -3S	SPECIAL CHECK	COMPLETE	STUDENT'S NAME / SSN / RANK
	CORRECTION	INCOMPLETE	

CNATRA 1542/274 (10-83)

AVIATION TRAINING FORM/BASIC INSTRUMENTS, BI-4S	SQUADRON (VT/HT)

U	BA	A	AA	I/O		ITEM	COMMENTS
				P	1	Headwork	
				P	2	Basic airwork	
				P	3	Procedures	
				P	4	Emergency procedures	
				I	5	Penetration maneuver	
				I	6	S-1 pattern	
				P	7	Straight and level	
				P	8	ICA	
				P	9	CRC/D	
				P	10	Unusual attitudes(full panel)	
				P	11	Constant rate turns	
				P	12	GCA maneuver	
				P	13	Direct to a VOR/TACAN	

U	BA	A	AA	ITEM	FLIGHT TIME LOG											
				TOTAL MARKS THIS FLIGHT	DATE	FLT DUR	FP	CP	SC	NIGHT	LANDINGS FIELD	LANDINGS SHIP	INST	ACT	SIM	APPROACH TYPE/NO
				TOTAL CARRIED FORWARD	JULIAN DATE											
				CUMULATIVE STAGE TOTAL		CUM TOTAL										

CLASS NO.	WARM UP	UP	INSTRUCTOR'S SIGNATURE
AIRCRAFT 2B-37	EXTRA TIME	DOWN	
	CHECK FLIGHT	SAFE FOR SOLO	INSTRUCTOR'S NAME / SSN / RANK
STAGE BI	RECHECK	UNSAFE FOR SOLO	
	SPECIAL CHECK	COMPLETE	STUDENT'S NAME / SSN / RANK
EVENT -4S	CORRECTION	INCOMPLETE	

CNATRA 1542/275 (10-83)

AVIATION TRAINING FORM/BASIC INSTRUMENTS. BI-5S

SQUADRON (VT/HT)

PERFORMANCE APPRAISAL							COMMENTS
U	BA	A	AA	I/O		ITEM	
				P	1	Headwork	
				P	2	Basic airwork	
				P	3	Procedures	
				P	4	Emergency procedures	
				I	5	BAC maneuver	
				I	6	Approach pattern	
				P	7	ICA	
				P	8	GCA maneuver	
				P	9	Unusual attitudes(full panel)	
				P	10	Constant rate turns	
				P	11	CRC/D	
				P	12	S-1 pattern	
				P	13	Penetration	
				P	14	Direct to a VOR/TACAN	

U	BA	A	AA	ITEM	FLIGHT TIME LOG											
				TOTAL MARKS THIS FLIGHT	DATE	FLT DUR	FP	CP	SC	NIGHT	LANDINGS FIELD	LANDINGS SHIP	INST	ACT	SIM	APPROACH TYPE/NO
				TOTAL CARRIED FORWARD	JULIAN DATE											
				CUMULATIVE STAGE TOTAL		CUM TOTAL										

CLASS NO.	WARM UP	UP	INSTRUCTOR'S SIGNATURE
	EXTRA TIME	DOWN	
AIRCRAFT 2B-37	CHECK FLIGHT	SAFE FOR SOLO	INSTRUCTOR'S NAME / SSN / RANK
STAGE BI	RECHECK	UNSAFE FOR SOLO	
EVENT -5S	SPECIAL CHECK	COMPLETE	STUDENT'S NAME / SSN / RANK
	CORRECTION	INCOMPLETE	

CNATRA 1542/278 (10-93)

AVIATION TRAINING FORM/BASIC INSTRUMENTS, BI-6S	SQUADRON (VT/HT)

U	BA	A	AA	I/O		ITEM	COMMENTS
				P	1	Headwork	
				P	2	Basic airwork	
				P	3	Procedures	
				P	4	Emergency procedures	
				I	5	Partial panel straight & level	
				I	6	Partial panel timed turns	
				I	7	Partial panel enroute descent	
				P	8	ICA	
				P	9	GCA maneuver	
				P	10	Unusual attitudes (Full panel)	
				P	11	Direct to a VOR/TACAN	
				P	12	S-1 pattern	
				P	13	Penetration	
				P	14	BAC maneuver	
				P	15	Approach patten	

U	BA	A	AA	ITEM	FLIGHT TIME LOG										
				TOTAL MARKS THIS FLIGHT	DATE	FLT DUR	FP	CP	SC	NIGHT	LANDINGS FIELD	LANDINGS SHIP	INST	ACT	SIM	APPROACH TYPE/NO
				TOTAL CARRIED FORWARD	JULIAN DATE										
				CUMULATIVE STAGE TOTAL		CUM TOTAL									

CLASS NO.	WARM UP	UP	INSTRUCTOR'S SIGNATURE
AIRCRAFT 2B-37	EXTRA TIME	DOWN	INSTRUCTOR'S NAME / SSN / RANK
STAGE BI	CHECK FLIGHT	SAFE FOR SOLO	
	RECHECK	UNSAFE FOR SOLO	STUDENT'S NAME / SSN / RANK
EVENT -6S	SPECIAL CHECK	COMPLETE	
	CORRECTION	INCOMPLETE	

CNATRA 1542/277 (10-83)

CNATRAINST 1542.59C

AVIATION TRAINING FORM/BASIC INSTRUMENTS, BI-7	SQUADRON (VT/HT)

U	BA	A	AA	I/O		ITEM	COMMENTS
				P	1	Headwork	
				P	2	Basic airwork	
				P	3	Procedures	
				P	4	Emergency procedures	
				I	5	ICA	
				P	6	Straight and level	
				P	7	CRC/D	
				P	8	CABT	
				I	9	GCA	
				I	10	Approach pattern	
				I	11	Unusual attitudes(full panel)	
				I	12	Penetration	
				I	13	BAC	
				D	14	VERITGO (R/C) Unhooded	

U	BA	A	AA	ITEM	FLIGHT TIME LOG
				TOTAL MARKS THIS FLIGHT	DATE
				TOTAL CARRIED FORWARD	JULIAN DATE
				CUMULATIVE STAGE TOTAL	

FLT DUR	FP	CP	SC	NIGHT	LANDINGS FIELD	LANDINGS SHIP	INST ACT	INST SIM	APPROACH TYPE/NO
CUM TOTAL									

CLASS NO.	WARM UP	UP	INSTRUCTOR'S SIGNATURE
AIRCRAFT T-34C	EXTRA TIME	DOWN	
	CHECK FLIGHT	SAFE FOR SOLO	INSTRUCTOR'S NAME / SSN / RANK
STAGE BI	RECHECK	UNSAFE FOR SOLO	
	SPECIAL CHECK	COMPLETE	STUDENT'S NAME / SSN / RANK
EVENT -7	CORRECTION	INCOMPLETE	

AVIATION TRAINING FORM/BASIC INSTRUMENTS, BI-8S

SQUADRON (VT/HT)

PERFORMANCE APPRAISAL							COMMENTS
U	BA	A	AA	I/O		ITEM	
				P	1	Headwork	
				P	2	Basic airwork	
				P	3	Procedures	
				P	4	Emergency procedures	
				I	5	Unusual attitudes(partial panel)	
				P	6	ICA	
				P	7	GCA maneuver	
				P	8	Approach pattern	
				P	9	S-1 pattern	
				P	10	Penetration	
				P	11	BAC maneuver	
				P	12	Partial panel stright & level	
				P	13	Partial panel timed turns	
				P	14	Partial panel enroute descent	
				P	15	Direct to a VOR/TACAN	

U	BA	A	AA	ITEM	FLIGHT TIME LOG											
					DATE	FLT DUR	FP	CP	SC	NIGHT	LANDINGS FIELD	LANDINGS SHIP	INST	ACT	SIM	APPROACH TYPE/NO
				TOTAL MARKS THIS FLIGHT												
				TOTAL CARRIED FORWARD	JULIAN DATE											
				CUMULATIVE STAGE TOTAL		CUM TOTAL										

CLASS NO.	WARM UP	UP	INSTRUCTOR'S SIGNATURE
AIRCRAFT 2B-37	EXTRA TIME	DOWN	
	CHECK FLIGHT	SAFE FOR SOLO	INSTRUCTOR'S NAME / SSN / RANK
STAGE BI	RECHECK	UNSAFE FOR SOLO	
EVENT -8S	SPECIAL CHECK	COMPLETE	STUDENT'S NAME / SSN / RANK
	CORRECTION	INCOMPLETE	

CNATRA 1542/279 (10-83)

AVIATION TRAINING FORM/BASIC INSTRUMENTS. BI-9S

SQUADRON (VT/HT)

U	BA	A	AA	I/O		ITEM	COMMENTS
				P	1	Headwork	
				P	2	Basic airwork	
				P	3	Procedures	
				P	4	Emergency procedures	
				P	5	ICA	
				P	6	GCA maneuver	
				P	7	Approach pattern	
				P	8	Direct to a VOR/TACAN	
				P	9	Partial panel	
				P	10	S-1 pattern	
				P	11	Penetration	
				P	12	BAC maneuver	
				P	13	Unusual attitudes(full panel)	
				P	14	Unusual attitudes(partial panel)	

U	BA	A	AA	ITEM	FLIGHT TIME LOG											
				TOTAL MARKS THIS FLIGHT	DATE	FLT DUR	FP	CP	SC	NIGHT	LANDINGS FIELD	LANDINGS SHIP	INST	ACT	SIM	APPROACH TYPE/NO
				TOTAL CARRIED FORWARD	JULIAN DATE											
				CUMULATIVE STAGE TOTAL		CUM TOTAL										

CLASS NO.	WARM UP		UP		INSTRUCTOR'S SIGNATURE
AIRCRAFT 2B-37	EXTRA TIME		DOWN		
	CHECK FLIGHT		SAFE FOR SOLO		INSTRUCTOR'S NAME / SSN / RANK
STAGE BI	RECHECK		UNSAFE FOR SOLO		
	SPECIAL CHECK		COMPLETE		STUDENT'S NAME / SSN / RANK
EVENT -9S	CORRECTION		INCOMPLETE		

CNATRA 1542/280 (10-93)

AVIATION TRAINING FORM/BASIC INSTRUMENTS, BI-10

SQUADRON (VT/HT)

PERFORMANCE APPRAISAL							COMMENTS
U	BA	A	AA	I/D		ITEM	
				P	1	Headwork	
				P	2	Basic airwork	
				P	3	Procedures	
				P	4	Emergency procedures	
				P	5	ICA	
				I	6	Unusual attitudes(partial panel)	
				I	7	S-1	
				I	8	Partial panel	
				P	9	GCA	
				P	10	Approach pattern	
				P	11	Unusual attitudes(full panel)	
				P	12	Penetration	
				P	13	BAC	

U	BA	A	AA	ITEM	FLIGHT TIME LOG											
				TOTAL MARKS THIS FLIGHT	DATE	FLT DUR	FP	CP	SC	NIGHT	LANDINGS FIELD	LANDINGS SHIP	INST	ACT	SIM	APPROACH TYPE/NO
				TOTAL CARRIED FORWARD	JULIAN DATE											
				CUMULATIVE STAGE TOTAL		CUM TOTAL										

CLASS NO.	WARM UP		UP		INSTRUCTOR'S SIGNATURE
	EXTRA TIME		DOWN		
AIRCRAFT T-34C	CHECK FLIGHT		SAFE FOR SOLO		INSTRUCTOR'S NAME / SSN / RANK
STAGE BI	RECHECK		UNSAFE FOR SOLO		
EVENT -10	SPECIAL CHECK		COMPLETE		STUDENT'S NAME / SSN / RANK
	CORRECTION		INCOMPLETE		

CNATRA 1542/291 (6-93)

AVIATION TRAINING FORM/BASIC INSTRUMENTS, BI-11	SQUADRON (VT/HT)

PERFORMANCE APPRAISAL							COMMENTS
U	BA	A	AA	I/O		ITEM	
				P	1	Headwork	
				P	2	Basic airwork	
				P	3	Procedures	
				P	4	Emergency procedures	
				P	5	ICA	
				P	6	GCA	
				P	7	Approach pattern	
				P	8	S-1	
				P	9	Partial panel	
				P	10	Unusual attitudes(full/PP)	
				P	11	Direct to a VOR/TACAN	
				P	12	Penetration	
				P	13	BAC	

U	BA	A	AA	ITEM	FLIGHT TIME LOG											
				TOTAL MARKS THIS FLIGHT	DATE	FLT DUR	FP	CP	SC	NIGHT	LANDINGS FIELD	LANDINGS SHIP	INST	ACT	SIM	APPROACH TYPE/NO
				TOTAL CARRIED FORWARD	JULIAN DATE											
				CUMULATIVE STAGE TOTAL		CUM TOTAL										

CLASS NO.	WARM UP		UP		INSTRUCTOR'S SIGNATURE
	EXTRA TIME		DOWN		
AIRCRAFT T-34C	CHECK FLIGHT		SAFE FOR SOLO		INSTRUCTOR'S NAME / SSN / RANK
STAGE BI	RECHECK		UNSAFE FOR SOLO		
	SPECIAL CHECK		COMPLETE		STUDENT'S NAME / SSN / RANK
EVENT -11	CORRECTION		INCOMPLETE		

CNATRA 1542/232 (10-83)

AVIATION TRAINING FORM/BASIC INSTRUMENTS, BI-12X

SQUADRON (VT/HT)

PERFORMANCE APPRAISAL							COMMENTS
U	BA	A	AA	I/D		ITEM	
				R	1	Headwork	
				R	2	Basic airwork	
				R	3	Procedures	
				R	4	Emergency procedures	
				R	5	ICA	
				R	6	Direct VOR/TACAN	
				R	7	Approach pattern	
				R	8	GCA	
				R	9	Partial panel	
				R	10	Unusual attitudes(Full/PP)	
				R	11	S-1	
				R	12	Penetration	
				R	13	BAC	

U	BA	A	AA	ITEM	FLIGHT TIME LOG											
					DATE	FLT DUR	FP	CP	SC	NIGHT	LANDINGS FIELD	LANDINGS SHIP	INST	ACT	SIM	APPROACH TYPE/NO
				TOTAL MARKS THIS FLIGHT												
				TOTAL CARRIED FORWARD	JULIAN DATE											
				CUMULATIVE STAGE TOTAL		CUM TOTAL										

CLASS NO.	WARM UP	UP	INSTRUCTOR'S SIGNATURE
	EXTRA TIME	DOWN	
AIRCRAFT T-34C	CHECK FLIGHT	SAFE FOR SOLO	INSTRUCTOR'S NAME / SSN / RANK
STAGE BI	RECHECK	UNSAFE FOR SOLO	
EVENT -12X	SPECIAL CHECK	COMPLETE	STUDENT'S NAME / SSN / RANK
	CORRECTION	INCOMPLETE	

CNATRA 1542/233 (10-83)

APPENDIX D
STATISTICAL PROCEDURES

In presenting data in this report, several types of statistics are used. To summarize the general nature or typical value for a group of measures, descriptive statistics such as the Arithmetic Mean (M) and Standard Deviation (SD) are used. The M is that statistic which is commonly referred to as "the average," while the SD is an indicator of the degree of variability among individual measures about the group M value.

In evaluating whether two or more sets of data (e.g., control and experimental groups) differ to a degree greater than might be expected by chance, various statistical significance tests are used. In the present report, these are the t-test and the analysis of variance (ANOVA).

Degree of departure from chance expectation is expressed in terms of probability statements. For example, the expression $p<.05$ means that the probability is less than five in 100 that the difference is due to chance alone; $p<.01$ means that the probability is less than one in 100, and so on. Thus, the smaller the probability figure, the more significant a difference is and the less likely it is due to chance variation. In keeping with statistical convention, differences are not considered statistically significant here unless the probability is 5 in 100 or less. [Ref. 26: p. C-1]

The ANOVA test yields a statistic called the F ratio, which is the ratio of two variance estimates, and it is this F statistic that allows the probability determination. Similarly, the t-test yields a statistic that permits a probability determination of the significance of a difference. In both the ANOVA and t-tests, reference is made to

df, or degrees of freedom. The df refers basically to the number of independent measures on which the test is based.

The reader desiring more information of such statistical analysis and test procedures is referred to any one of the large number of standard statistical textbooks available. For example, see:

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APPENDIX E

BASIC INSTRUMENTS FLIGHT PROCEDURES LECTURE GUIDELINES

DISCIPLINE: Flight Support Instruction

COURSE TITLE:
Basic Instrument Flight Procedures,
T-34C (Primary)

UNIT:
Basic Instrument Flight Procedures, Lecture

PREREQUISITES: Completion of MOD 1; prior to BI-1s

FOR INSTRUCTIONAL PURPOSES ONLY

SCOPE: The specific purpose of this lecture is to introduce the student to basic instrument procedures in order to develop the necessary instrument flying skills to advance to Radio Instruments.

SPECIFIC INSTRUCTIONAL OBJECTIVES

1. At the completion of this unit, the student will:
1.1 Know the concepts of attitude instrument flight.
1.2 Know the importance and method of scan techniques.
1.3 Know the Instrument Checklist and function of all items covered.
1.4 Define the terms used in basic instruments.
1.5 Know the required voice reports.
1.6 Know the procedures and scan for:
1.6.1 Initial climb to altitude.
1.6.2 Straight and Level flight, with associated corrections.
1.6.3 Constant Angle of Bank Turns.
1.6.4 Rate Turns.
1.6.5 Constant Airspeed Climbs and Descents.

1.6.6 Constant Rate Climbs and Descents.
1.6.7 Penetration Pattern.
1.6.8 Basic Approach Configuration.
1.7 Know the procedures for the following patterns:
1.7.1 GCA Maneuver.
1.7.2 Approach Pattern.
1.7.3 S-1 Pattern.
1.8 Know the recovery procedures for unusual Attitudes.
1.9 Understand and describe the effects of an A/C power failure.
1.10 Know the procedures for the following Partial Panel Maneuvers:
1.10.1 Straight and Level.
1.10.2 Timed Turns.
1.10.3 Enroute Descent.
1.10.4 Unusual Attitudes.
1.11.1 Know the procedures for flying direct to a VOR/TACAN.

2. Visual Aids.
  a. T-34C Instrument Panel Schematic Diagram.
  b. Attitude gyro/flight instrument training device.

DIRECTIONS TO THE INSTRUCTOR

1. This lecture and all material covered herein is not designed to be a replacement for the FTI. It is designed to be supplemental information and to introduce to the student scan, trim, and flight procedures.

2. Deliver the lecture and answer student questions referring them to reference material as appropriate.

APPENDIX F

APPLE COMPUTER SCAN TRAINER

The Scan Trainer Program was written using APPLE Writer IIe and includes T-34C instrument panel schematic in the upper three-quarters of the screen plus 4 lines of 40 column script filling the lower quarter of the screen.

Instrument display variations are presently limited to a nine situation attitude gyro and a three situation turn needle. The remaining instruments (VSI, ALTIMETER, etc.) illuminate with the short title displayed in the corresponding schematic instrument panel position.

Each scan trainer loop offers 1,3,or 5 cycles and three speeds of execution which can be interrupted using the "escape" command. Scan sequence dynamics were achieved by designing a standard time delay (SD) period then sequencing one or more SD periods between instrument scan sequence components producing a dynamic trainer.

In addition, a "wait key" function permits sequential frames of text material coupled with supporting instrument panel displays to be provided to the student. Sufficiently simple to be self-explanatory, the program is self-supporting with key selections clearly identified along the way.

An example of the program is the scan entry to a standard rate level right turn from LS (level, straight) attitude followed by Level Right (LRA). The remaining elements Bank Right (BR), Turn Needle Deactivate (TND), VSI Activate (VSA) and VSI Deactivate (VSD), etc., merely reflect and reinforce the exact linear scan presented in the Basic Instruments Flight Training Instructions (FTI). In addition, each instrument maneuver can be duplicated through the scan trainer so that the student can gain a sense of time

involved in the maneuver execution. Not only did the scan pattern work well in loop but it is equally well suited to provide a quick refresher for attitude instrument flight fundamentals for both instructor training and student familiarization.

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